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THE NEW TELEPHONE EXCHANGE OF BERLIN.*

By Emile Guarini.

Telephone Exchange No. IV., of Berlin, which has just been supplied with a Siemens & Halske multiple commutator, is one of the largest of those in the world that are provided with horizontal switchboards, the capacity of each, in this new installation, being for 14,000 subscribers (Fig. 1). The cables entering the basement, from the street, are introduced into junction boxes (Fig. 2), and from these pass directly to the principal distributor (Fig. 3). The apparatus serves for making connections between the conductor of a subscriber and the two conductors that start from a commutator. The distributor consists of an iron frame to which are secured parallel wooden uprights. Each of these latter is provided with a double row of binding screws. Two screws, placed side by side, hold the extremity either of the conductor of a subscriber or of a conductor connected with the commutators and call-bells. Each of these two kinds of end connections is placed upon one of the halves of the upright, the extremities of the subscribers' conductors being upon the lower half and those of the others upon the upper. The cable that leads the subscribers' conductors from the exterior passes, therefore, from the boxes above mentioned to the lower halves of the uprights, while the different double conductors pass to the upper part of the same. The corresponding pairs of subscribers' and double conductors are connected by insulated cables established in the rear of the distributing racks. The faces of the iron frame are turned toward each other in pairs and form interspaces faced with 72 uprights, each comprising 3 x 20 + 2 x 28 pairs of binding screws. About 69,000 of these screws are established in the distributor, which occupies a surface measuring 16.4 x 13 feet by 8.2 feet in height.

From the principal distributor, the conductors, united in cables, ascend to the telephone hall and are then led in the cable conduits under the switchboards to the commutators. In the Siemens & Halske system, the corresponding commutators are in series. After passing through the entire series of commutators of the switchboard, the cable conduit passes to the intermediate distributor, the management of which is identical with that of the principal one.

The commutators are placed in two halls, one of them 68.8 x 59 feet, and the other 55.4 x 29.5. The main hall contains three parallel switchboards, each composed respectively of seven, eight and seven smaller ones. In the other hall there is a board composed of five parts. There are in all, therefore, 27 switchboards, each accommodating 14,000

FIG. 1.—HORIZONTAL MULTIPLE SWITCHBOARD.

FIG. 2.—JUNCTION BOXES.

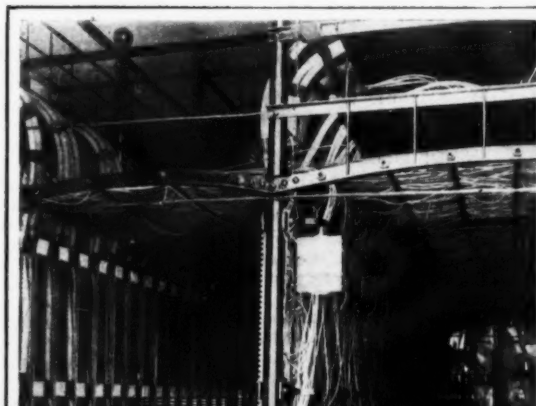


FIG. 3.—MAIN DISTRIBUTOR.

THE NEW TELEPHONE EXCHANGE OF BERLIN.

*Specially prepared for the Scientific American Supplement.

subscribers, and having from 400 to 800 service conduits. Each board measures 7 x 4.25 feet. These boards are operated by 162 young women. Each operator has 100 subscribers to serve. This is a peculiarity of the Siemens & Halske system, which, through the great simplicity of service that results therefrom, has rendered possible a great increase in effective work without fatiguing the operators or interfering with the rapidity of the communications.

For connecting the service with other exchanges, there are about 2,220 conduits, 1,200 of which start from the exchange and 1,020 end there. Special sides are reserved for them at the switchboards. As the telephone exchanges of Berlin are provided with a night service, which is assured in each of them by at least two operators, it became necessary to establish a signal arrangement, which indicates to the operator the line whence the call proceeds. At the ends of each general switchboard, there are two large incandescent lamps with ground glass globes, and each is designed for the half-board at the end of which it is placed. If there is a call, the lamp that belongs to the division whence it emanated is lighted, and, at the same time, the ringing of a bell attracts the attention of the operator, and a control lamp becomes lighted and indicates the group in which the call has been made. Finally, a special lamp indicates the spring-jack.

Despite the size of the exchange, its installation occupied but 17 weeks. It is to be remarked, however, that a large number of the parts and cables had been previously mounted. At present, the exchange comprises 428,500 spring-jacks for subscribers, 11,020 for calls, 2,400 commutators, and 2,400 signals. The total length of the cables is 91.75 miles. It required the making of 1,500,0C splices, which necessitated the use of twelve hundredweights of solder. Since, in such an installation, the safety and insulation of the current conductors is of the greatest importance, every part of the distributing rack, every cable, and every splice had to be tested. Let us remark, in conclusion, that the halls, which are over thirty feet in height, permit of the entrance of plenty of light from the exterior. During the hours of darkness the lighting is done by means of arc lamps suspended from the walls.

We shall not extend our description to a greater length, since the accompanying illustrations will permit of grasping the details of the arrangement. We shall simply remark, in conclusion, that Central Exchange No. IV., in addition to being one of the largest of those provided with horizontal switchboards, seems to be, if not the best, at least one of the best organized ones in the world, and, on this account, is worthy of being brought to the attention of the reader.

PRESENT METHODS OF DYEING.*

THE actions manifested during the various operations of dyeing have often been the object of theoretical study attended with the expression of different views. My intention is not to treat the question in a purely theoretical manner, but to endeavor to explain the phenomena of dyeing according to observations made industrially.

The various kinds of dyeing are to be assigned to different groups, but these groups cannot be considered as absolute, because each colorant must be submitted to a special study, having regard to the manner in which it behaves with one or with different fibers. Every colorant has special qualities, which must be considered separately. Even the definition *dyeing* must be rendered precise. We may thus describe it. Under the term dyeing every operation is to be included by which a solid body (a fiber) absorbs or attracts a colorant from a comparatively dilute solution.

In what follows we cannot study the manner in which each colorant behaves; we can only notice the different groups in general. The operations may be divided into two principal groups; direct operations and indirect operations.

DIRECT OPERATIONS.

In this category we have to class the direct dyeing of animal and vegetable fibers; that is, the dyeing without previous mordanting or fixing, or subsequent development. Certain phenomena of the direct dyeing of animal fibers tend to lead us to believe that there is a chemical combination between the coloring matter and the fiber. I was personally of this opinion until lately. But after detailed observations and reflections I am obliged to abandon this view. The shading of wool with a trace of coloring matter by means of a boiling bath, and the union which is thus obtained, are operations not in accord with chemical reactions. Besides, the fiber remains after dyeing still a fiber, and the colorant remains still a colorant. If, during the dyeing, there were a chemical reaction, we would have an *ensemble* with new characteristics, which is not the case. There are other points not accordant with chemical reactions which cannot now be enumerated.

According to the character of the shades on the fibers and the observations made, direct dyeing rests: (A) On the absorbing power of the fibers in a medium favorable for certain colorants or for their solutions; (B) on the adherence of certain colorants, or on absorption and adherence. In these different cases capillarity and porosity play a certain rôle, as well as the fiber itself; first as a vehicle, secondly as a contact substance.

A. Dyeing by Absorption.

The dyeing of wool with sulpho-colorants rests on the absorbing power of this fiber in a medium propitious for sulpho-coloring matters or for their free acids. On dyeing with these colorants in acid baths, the addition of the acid is designed to set the acid of the colorant at liberty, and to facilitate the absorption of this acid. The free acid of certain colorants is but slightly absorbed in a neutral bath; thus, the free acid of crystallized ponceau, on dyeing for an hour in neutral bath (distilled water), is comparatively but little absorbed by wool technically pure (wool in flock, which has been freed from grease by carbon sulphide and afterward washed thoroughly with hot distilled water); the wool, instead of being red, is only strongly tinted rose. If to this bath acetic or sulphuric acid is added, operating under the same conditions, the free acid of the crystallized ponceau is completely absorbed. The absorption in the latter case with sulphuric acid is more rapid than in the first with addition of acetic acid.

On dyeing under the same conditions with the soda salt of crystallized ponceau, the wool does not absorb the colorant in neutral bath; on the contrary, in acid bath it absorbs in the same way as in dyeing with free acid. Wool which had been previously treated with 10 per cent of sulphuric acid in boiling bath and afterward washed several times a day for six days with boiling distilled water, and which between times was left in distilled water, had after the sixth day still an acid reaction and absorbed the crystallized ponceau salt very rapidly in neutral bath. These experiments, which have all been made for an hour in solution, demonstrate the eventual rôle of the acid in dyeing by means of an acid bath, and justify us in concluding that it is possible that the wool commences by absorbing the acid or a part of it, which excites in it the power of absorbing the colorants. This cannot, however, be admitted as a general rule. Certain colorants, such as alkaline blues, are absorbed by wool in alkaline bath; others, like naphthol black 12 B, Indian yellow, formyl violet, direct colorants for cotton, are absorbed in neutral bath, and even one slightly alkaline. The absorption in these cases is not complete, but becomes so, if the dyeing is conducted in bath, acid or slightly acid. The absorbing power of the wool for acid colorants or for the salts of acid colorants is consequently more pronounced in an acid medium than in a medium neutral or slightly alkaline.

On dyeing wool practically in an acid bath, sodium sulphate is added. The sodium sulphate is intended to lessen the action of the acid by formation of the bisulphate of soda. We may also assume that the solutions of sulphate of soda or of the bisulphate of soda diffuse the coloring matters more or less rapidly, and that by this fact the colorants are either taken up in a more regular way, or absorbed more regularly. When large quantities of sodium sulphate are employed, 20 to 30 per cent of the weight of the wool, it acts as a conductor of heat; the heat is distributed more uniformly in the bath, and the large quantity of the salt allows boiling at a higher temperature. This is especially to be considered when tissues of wool are dyed with steam direct; then success is assured by a comparatively moderate addition of the sodium sulphate, causing the bath to boil at 100 deg. C. The action of sulphuric acid does not take place in general except at a certain temperature; that is, the acid really acts only when the bath has reached a certain temperature. This phenomenon may be well observed in dyeing; when the wool is put in cold, it does not dye on heating; it may be observed, according to the colorant, that only at about 50 deg., 60 deg. C., or above, the wool commences to be dyed. We may assume that in a bath of sulphuric acid at this temperature, which differs for each colorant, the acid of the colorant (coloric acid) is set at liberty, and that as such it is more readily absorbed by the wool. I am decided in this view after having observed that, in dyeing with the free acid of colorants (obtained by treating their salts in concentrated boiling bath with the corresponding quantity of sulphuric acid), on making use of a normal bath cold, the wool is dyed from the start more rapidly than with the corresponding salt. With respect to the temperature, it may be said that the absorbing power of the wool for colorants is more pronounced at a high than at a low temperature, that the fibers of the wool open to the heat and swell, favoring the absorption.

On dyeing in baths of acetic acid, the action is similar; only the acid of the colorant is not set at liberty; or, if it is, only by the heat. Besides, the absorbing power of the wool in a medium of acetic acid ought to be considered as weaker than in a medium of sulphuric acid; for this reason all colorants do not dye in a bath of acetic acid, and those that do, behave in this bath differently than in a bath of sulphuric acid.

The exhaustion of the colorants in baths of acetic acid by the addition of sulphuric acid, may have two reasons: First, the increase of the absorbent power of the wool, and afterward the setting at liberty the acid of the colorant, which is still in the form of a salt in the bath, and then more easily absorbed. It is probable that both causes act simultaneously. The absorbing power varies for different colorants, and goes on until saturation, after which the baths are no longer exhausted; whence but little of the colorant is fixed, and that superficially by adherence.

The property of a colorant to unite readily rests on its solubility in the medium in which it is dyed; the more soluble it is, the more readily it is diffused. A colorant absorbed by the wool when it is sufficiently soluble is again dissolved by the dyeing bath, to be absorbed anew in another place, and so on. On the same principle reposes the union by prolonged boiling of certain colorants. The following law may consequently be enunciated: The union of a colorant is proportional to its solubility in the dyeing bath.

It is necessary to accentuate the expression *solubility in the dyeing bath*, because certain colorants are more soluble in acidulated water than in ordinary or distilled water, and *vice versa*. The solidity of direct dyes in washing rests on the absorbing power, greater or less, by which the colorant is retained; besides, the solubility of the colorant in the medium in which it is treated exerts a very important action.

The reason why certain colorants for wool are absorbed in a different shade than in that which they have in acid solution, such as tropeoline (orange IV, metanile yellow), carmine blue, cyanol, etc., is to be attributed to the fact that these colorants or their free acids receive an addition of acid on changing their shades, in a manner similar to that of Congo red. The additional acid is afterward eliminated from the fiber by absorption, which in this case would act as a contact substance; and it is only the colorant, or the normal acid of the colorant, which is absorbed by the fiber. I explain the fact in this way, that there is no chemical action between the colorant and the fiber. When cotton is dyed in acid bath with orange IV, the fiber appears to absorb the violet tint of the bath. On taking out the cotton and pressing it well, so as to remove the excess of the bath, the cotton appears to be dyed yellow. This tint, as well as that on wool, appears still better after rinsing with distilled water. That these colorants or their acids may receive acid and abandon it readily is conclusive from the fact that on diluting these solutions with distilled water the normal shade reappears in solutions sufficiently diluted.

The direct dyeing of cotton with substantive azo colorants constitutes a part of this group because these tints, as well as those of acid colorants on wool, do not soil under dry friction. The direct dyeing with sulpho-colorants is to be classed in the same category, although in the case of these colorants the adherence acts a certain part. Their colors are in reality a little less solid to friction than those of the direct azo-colorants.

Generally, the dyeing on cotton with azo-colorants direct is considered as a precipitation, a "salting" of the colorant on the fiber. This view, however, is not correct. For in the case of salting, precipitating a colorant on the fiber, by adding sufficient of the salt in the dye bath, a color is obtained which soils very much under friction; the colorant is in this case deposited on the fiber by adherence. The normal shades are, consequently, the result of a different phenomenon which may be considered, as already indicated, a phenomenon of absorption of the colorant by the fiber.

In this kind of dyeing the alkalies act as a solvent of the coloring matter; the salts, sodium chloride, or sulphate of soda saturate the bath, but the solution of coloring matter is not well diffused with that of the salts, and by this latent state of separation of the coloring matter it is more rapidly absorbed by the fiber. On heating the dye-bath the heat acts first on the colorant, rendering it more soluble, then on the fiber, swelling it and thus rendering it more suitable for absorbing in a uniform way and of enabling the colorant to penetrate more readily.

When wool and cotton thread or tissues (milaine, half wool) are dyed with substantive azo-colorants in neutral bath, the colorants generally behave in a different way with respect to the two fibers. This is to be attributed to the different degrees of absorption of the fibers, then to the different catalytic action of the fibers, that is, to their different action as contact substance. That these colorants are usually taken up from the bath more by the wool than by the cotton, is to be attributed to this: That the cotton loosens from the colorant, and that the absorbing power of the wool at this temperature is more pronounced than that of the cotton. For colorants which under the same conditions are taken up more by the cotton than by the wool, the absorbing power of the latter is to be considered as less than that of the cotton.

On the contrary, the point is complicated for colorants which are taken up from the same bath in different shades on the two fibers. The explanation is much more difficult. At first thought it seems that this is the result of a chemical action between the wool and the colorant. If a chemical action really took place, proteic bodies, such as albumen, would behave in a similar way with respect to these colorants, but such is not the case. Cotton prepared with albumen is dyed the same shade as cotton not thus prepared, and not the shade of the wool.

As a standard colorant for this class of experiments, diamine blue 3 R may be made use of; this dyes cotton blue, and wool as well as silk reddish violet. The reducing action of the wool may thus have an influence on the shade; but wool previously oxidized is dyed the same shade as that which has not been oxidized, and by adding weak reducers to the dye-bath, such as glycerine, cotton is dyed the same tone as without these additions. On making these various experiments, I have remarked that the solution of these colorants, especially of diamine blue 3 R. is of the same shade as that of the wool, then that the shade of the cotton is not the same as that of the solution. An interesting fact is, that on putting the cotton in the dye-bath, it takes at first the color of the solution in the bath, the final color appearing only gradually; afterward, that the shade on the cotton of diamine blue 3 R, diamine black BH, and other colorants is, after being strongly heated (hot iron) nearly

* Abstract of communication of Justin Mueller to the Fifth International Congress of Chemistry.

the same as on wool at ordinary temperature. It seems consequently, *a priori*, that there is an analogy between the colorant on cotton in the very dry state and on wool in the ordinary state. The change of shade on the cotton with hot iron is generally attributed to a dehydration of the colorant, or to the fact that the colorant changes shade in the dehydrated state. To verify this view, I left cotton dyed with diamine blue 3 R overnight in a desiccator hermetically sealed; the next morning the color was reddish violet, of the same shade as that obtained by the action of the hot iron. When the dye was taken from the desiccator, it resumed its normal color as rapidly as after the action of the hot iron. By these experiments it is definitely established that the change of shade of cotton under the action of the hot iron is the result of dehydration of colorant. That certain colors do not change the shade with the hot iron, results from the fact that the colorants employed have the same shade in the hydrated state as in the dehydrated state.

It may be inferred from this that, with respect to the colors on wool in question, the colorant is on the wool in a dehydrated state; this, however, is not the case; for on wetting these colors, little or much, they do not change the shade, and with the hot iron they become the redder, consequently dehydrating. To examine how these colorants behave in the state of powder I diluted diamine blue 3 R with a neutral and dry vehicle, the fecula of potatoes. The shade was blue; on heating strongly it became violet red, and the original blue tint reappeared immediately on cooling; thus it may be concluded that the colorant itself is hydrated at the ordinary temperature.

B. Dyeing by Adherence.

On examining the shades obtained on wool with the colorants called basic, which are colorants of bi and tri-phenylmethane, and certain non-sulphureted azo-colorants, to which are to be added certain azine, oxazine and thiazine colorants, I found that they soiled a great deal under dry friction. From this fact these colorants are not in the same condition on the fiber as the so-called acid colorants, of which I have spoken previously. In this case the colorant is not intimately absorbed by the fiber; on the contrary, it remains deposited and adheres on and in the pores of the fiber. The fiber may indeed have a certain absorbent power for this kind of colorant; nevertheless, the adhering power is much more decided.

From the manipulation of the matter to be dyed in the dye-bath, the colorant adheres to the fiber. On raising the temperature of the bath, the fiber opens, the solution then penetrates better, and the colorant adheres more readily to the interior as well as to the surface; then by adherence and successive dissolution, the color is fixed.

The adhering and especially the absorbing power of silk for these colorants is much greater than that of wool; the silk absorbs them, and they adhere cold; besides, dyed with these colorants, it soils less under dry friction than wool, and with some of them, it does not soil at all. It has, consequently, for them an absorbing power comparatively great.

The coloring of glass by dye-baths, as well as that of enameled porcelain, is only a phenomenon of adherence.

In dyeing by adherence the colloidal character of the colorants plays probably a certain rôle.

The dyeing of jute, and up to a certain point that of linen, is accomplished in its *ensemble* more, or as much, by adherence as by absorption. Jute dyed with sulpho-colorants in acid bath, or in a bath of alum, soils a great deal under friction, as much as if dyed with basic colorant. Jute soils in general a little when dyed in neutral bath with substantive azo-colorants, but there are among them some, principally blues, which yield dyes that do not soil. These colorants may be considered as completely absorbed, which is not the case with colorants of this class which soil under friction. The latter are to be considered as partially adherent. Linen behaves with these colorants in a similar way. In this group of dyeing operations, we may include dyeing with reduced indigo, both on cotton and wool. The fiber is impregnated with a solution of reduced indigo; this on oxidizing deposits indigo on the fiber, which is fixed by adherence. The adhering power for indigo is more pronounced with wool than with cotton. In both cases the fiber becomes white by constant friction. It results from this fact that the colorant is not absorbed, but is deposited and adheres superficially.

Intermediate between these two classes of operations may be considered dyeing with aniline black in full bath on cotton. The ingredients of the bath are absorbed by the fiber, and the colorant is formed, not in the bath, but on the fiber itself, which serves as a vehicle. The color is deposited in the pores of the fiber and fixed there by adherence.

For aniline black (of oxidation) it may be said that the colorant in a certain phase of its formation is effectively absorbed by the fiber; this hypothesis is justified by the solidity under friction of the colorant formed.

In conclusion, the direct dyes, when they do not soil under dry friction, are to be considered as resulting from an absorption of the colorant by the fiber. When they soil slightly, the colorant, though being absorbed, adheres partially. When they soil under dry friction, such as basic colorants on wool, they are to be considered as a deposit, an adherence of the colorant on or in the pores of the fiber.

INDIRECT OPERATIONS.

In this group are especially included operations which necessitate previous mordanting; the colorant is not in this kind of dyeing directly absorbed or adherent to the fiber. On the contrary, it is produced on the fiber through the mordant; it is chemically combined by the mordant.

It includes also the direct dyes which necessitate an ulterior fixing or development, and the operations, timed as for dyeing, by which mineral colorants, azo and oxazinic, are produced on the fiber itself, which, as insoluble powders, are retained by adherence.

Correspondence.

THE FLIGHT OF BIRDS AND THE ART OF FLYING.

To the Editor of the SCIENTIFIC AMERICAN:

Your remarks in the issue of October 31, 1903, on some "Unconsidered Facts in the Art of Flying" are surprisingly correct for one who accepts current methods of mechanical analysis, and why you cannot see the case all through, when you see so far into it, is a puzzle to me.

No truer expression was ever made than that "the figures commonly accepted for the horse-power needed for mechanical flight per pound of weight supported are absurd when applied to birds."

Why not amplify that statement by continuing the same observation that produced it?

In 1876 I became interested in the migratory flight of sandhill cranes from Winnipeg to Sanibel Island on the gulf coast of Florida. In October and November these large birds, weighing 15 pounds each on an average, flapped themselves into the air to an elevation of say one-half a mile, when they would suddenly stop wing motion and proceed upward in great circles to a height of a mile approximately, when they would stop circling and proceed in a southerly direction until out of sight, uttering their distinguishing honk at intervals of a minute. Others would pass overhead at long intervals in the same direction, with wings stretched rigidly and motionless, and head and feet projected fore and aft.

I followed them to Sanibel, and saw them in the act of alighting in the midst of hundreds of their fellows who had preceded them. I had seen them pass high in the air at a score of places on the route, especially in the mountains of Tennessee, and in the multitude of cases thus observed, I never saw a wing motion from the time the journey was commenced to its end. In the act of coming down they would resume flapping. The arrivals were always from early dawn to a little after sunrise, and the journey was presumably made during the night, if a rough calculation from their observed speed was reliable.

But now comes the most remarkable thing connected with this astonishing translation. The birds exhibited not a trace of fatigue. They were full of fun and activity, jumping and dancing in the most grotesque manner. There were certainly not less than one thousand birds on the island, and on an arrival the whole crowd went crazy. The newcomers fairly outdid the company in gymnastics, keeping it up for an hour, and the question arises, what was the motive power that carried the animal against air resistance from Canada to the Spanish keys of Florida in one night? It obviously did not come from muscular exertion. A horse cannot even trot for a single mile without showing signs of work being done. Even a locomotive must rest at intervals. Leave all atmospheric *pressure* against the bird out of the case, and estimate the *friction* of air on its surface alone, and the case is one of perpetual motion pure and simple, if it is figured out on current methods. Mechanical science stands in absolute imbecility when confronted with the observed facts of that bird translation.

We have here a unique case, containing a new idea. The bird resembles a plane when its wings are extended, and there is some unknown relation existing between a plane's weight and its three reactions of inertia, friction, and pressure that enables its weight to move it horizontally. I am fully aware that gravity has no horizontal component, but pressure may be used to move the plane edgewise as it expands in escaping from beneath the surface. I have told how this is done in a paper on "Travel in Air" in the London Engineer of December 20, 1901, but that paper does not accept current scientific methods, and in fact flatly contradicts them. In my view the methods used by scientific men should harmonize with mechanical law; and when fluid pressure is declared to be normal by that law, confined to a definite straight line and existing only in that line, it absolutely cannot be treated as a composition of forces with any number of components. To treat weight of a plane inclined to horizontal as a component of pressure is more inherently absurd than any proposition of a perpetual motion crank. There is a very respectable statement that rests at the bottom of this case, known as Newton's third law of motion, which declares that action and reaction are opposite. I reject any method, no matter where it comes from, that flatly denies that law.

I. LANCASTER.

Chicago, Ill.

[The facts stated by Mr. Lancaster are of extreme interest. The distances covered by the sandhill cranes must be between 1,200 and 1,500 miles, perhaps more, and the time occupied is stated as thirteen or fourteen hours.

It should be noted that migrating birds seek the highest elevations for their long journeys at high speeds. Apparently the reason is the diminished resistance of the rarefied air. This must be materially less than it is at the earth's surface. Resistance is also reduced to a minimum by the form which the body and neck of the bird takes when stretched out in flight.

Long successful flight is always accomplished at a high rate of speed. This appears to be one of the essential features. The impact of the wing is so rapid that the inaction of the air is like that of a solid body.

Since we cannot watch the birds described by Mr. Lancaster and follow all their movements through the long hours of the night, we may perhaps be pardoned for making a guess. The hypothesis which seems most reasonable is that when the wings are motionless, the great birds are "coasting." Possibly several times during the night they may mount to higher elevations, or regain their initial elevation by flapping.

That coasting in the air with a very small grade is possible is readily proved by folding a sheet of paper into a sort of parachute. The angle of descent may be made very small indeed by a careful adjustment of weights. At the same time the horizontal motion becomes swift. It seems not at all improbable that a few inches per mile may be all that is needed to account for the marvelous work described.

The difficulty of flying appears in all the experiments, to be in starting with sufficient speed. The inertia of a fresh body of air is necessary to give the wing its resistance or support. When the motion is sufficiently swift, the resistance to displacement becomes so large that "slip" apparently disappears in the case of the larger birds. This seems to be taught by Prof. Langley's early experiments on falling planes.

In the famous gliding or "coasting" experiments of Lilienthal, as well as those of Mr. Octave Chanute in this country, the inertia of the air played an important part. In all of them it appeared that only a very little additional effort would have converted the glide into a continued flight. The safe means for alighting and a center of gravity placed too high were powerful needs.

The study of birds is most useful, especially in connection with the methods by which they check their speed and alight with safety. From the point of experimental economy this is even more desirable than to know just how they manage their wings. Flight will be an expensive pastime if one's machine is to be smashed each time a trip is finished.

While we cannot perhaps follow Mr. Lancaster's analysis in all its details, we are indebted to him for many important contributions to our knowledge of the flight of birds.—ED.]

CONTEMPORARY ELECTRICAL SCIENCE.*

THEORY OF COLLOIDAL SOLUTIONS.—J. Perrin supposes that every colloidal solution is made up of granules, invisible in the microscope, but much more bulky than the molecules, since they diffuse light considerably, and charged electrically, since they follow the lines of force in an electric field. The difficulty in the way of this conception lies in understanding why the larger granules do not absorb the smaller ones as in rain clouds, how the granules can grow and diminish reversibly with the temperature, and how, at a certain limit, an irreversible coagulation can set in, especially under the influence of polyvalent ions. To account for the stable equilibrium, the author supposes that the surface tension and cohesion which lead to the formation of granules are counteracted by the electrification which acts in a dissociating sense, and that at a certain point these two opposing forces are in equilibrium. The author traces the development of a granule from the first conglomeration of atoms to the time when it contains two similar electrons which tend to produce a "segmentation" of the granule by their mutual repulsion. When the granule becomes very large, or when polyvalent ions are present, the chances are overwhelmingly in favor of an equal quantity of both electricities, in which case the granule becomes an electric doublet, and there is nothing to counteract the tendency to coagulate.—J. Perrin, Comptes Rendus, October 12, 1903.

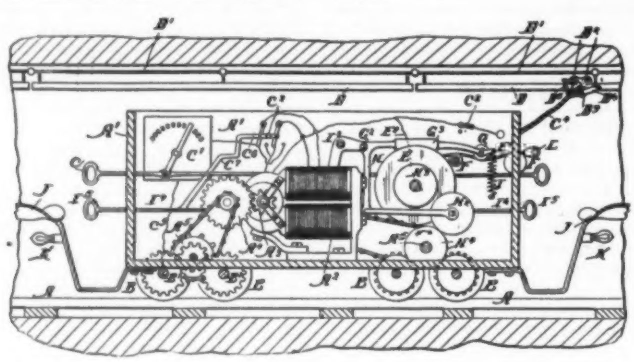
ALKALINE ACCUMULATORS.—The chief advantage of alkaline accumulators is that, apart from water, no constituent of the electrolyte enters into the reaction, and the liquid can, therefore, be much curtailed and the weight reduced. The oxidation of Cu_2O into CuO in an electrolyte of KHO and water takes place by the simple transference of oxygen from one electrode to the other through the medium of water, which disappears at one electrode and re-appears at the other. O. Schmidt points out that any metal whose oxides are insoluble in alkalies is suitable for alkaline accumulators. Such are the ordinary metals—cadmium, iron, nickel, copper, mercury, and silver. Zinc oxides are soluble in alkalies, but not in alkaline silicates, aluminates, or carbonates. Accumulators consisting of two electrodes of the same metal are most advantageous, since self-discharge by the accidental deposition of one metal upon the other is avoided. The difficulties encountered are mainly mechanical, and concern the mounting of the oxide in the shape of cohesive and yet porous masses. The oxide has to be prepared beforehand, as in Edison's nickel-iron accumulator, and contained in small metallic boxes closely packed. The oxide is utilized to a greater extent the nobler the metal. In silver the utilization reaches 100 per cent. The yield of Edison's accumulator is now 25 watt-hours per kilogramme, but the efficiency is less than that of the lead accumulators, and the price is higher.—O. Schmidt, Mitt. Phys. Ges. Zürich, No. 5, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.—I.*

By Frank C. Perkins.

The electric mining locomotive is now generally acknowledged to be the most convenient and economical form of motive power for mine haulage. The first electric locomotives utilized for underground work were installed but little more than a decade ago, but the rapid development in the application of electric power for mine service in general has placed the electric mining locomotive at the head of either steam or air systems as mechanical underground haulers. It is true, however, that in special cases compressed air locomotives as well as steam and rope haulage have been found most satisfactory, as best suited for those particular mines.

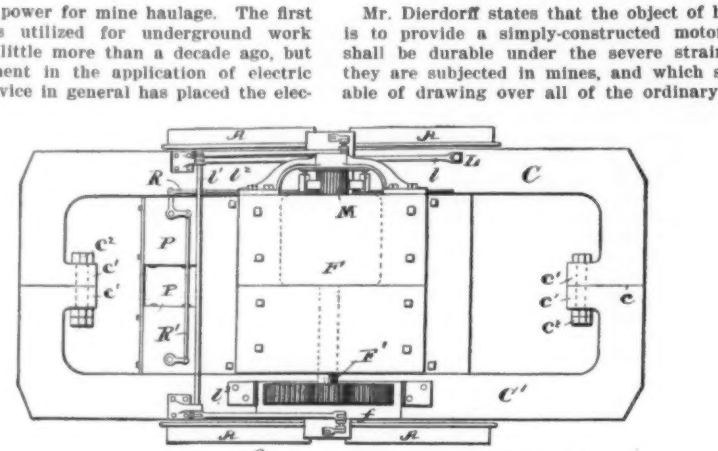


SPERRY SYSTEM OF TRANSPORTATION BY ELECTRICITY IN MINES.

The flexibility of the electric locomotive, allowing easy extensions, and its operation in narrow and low entries on account of its compactness, renders it particularly desirable for mining work.

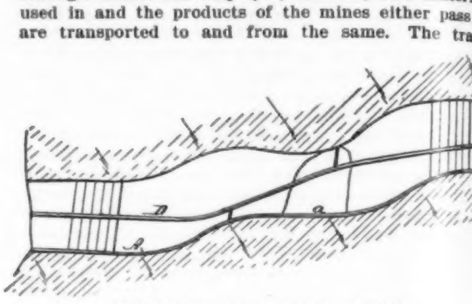
During the past ten years a number of patents for mining cars and locomotives, as well as systems of transportation and haulage by electricity in mines, have been obtained in this country by American engineers. In 1890 Mr. E. A. Sperry designed a system of transportation by electricity in mines, using a special electric traction car with automatic reeling devices and power transmission. Five years later an electrically-operated mining car was designed by Henry B. Dierdorff. In describing the application of his invention he says: "It is now well known to those that have had experience in using traction cars or motor cars in mines that there are a number of serious difficulties characteristic of the conditions and circumstances at such places, and not found in outside car work or transportation. The space or room both vertically and laterally for a motor car or traction car is exceedingly limited, in many cases the roofs being only four, five, and six feet from the floor, and the side walls being separated only eight or nine feet at the outside, within which latter space must come tracks, switches, and other matters which cramp the room. Again, the grades, relative to the horizontal of the track, vary greatly, they in some cases rising to five and six per cent. In such cases difficulties almost insuperable have been found in providing sufficient traction for transporting a train of coal cars of sufficient number to make it economical to operate in this manner. Resort has been had to cog tracks and traction wheels and various means for increasing the traction of the motor car upon the track. Further, there are frequent bends in the entries of relatively sharp curves, so that it is impossible to make the cars more than from seven to nine feet long, or thereabout."

Mr. Dierdorff states that the object of his invention is to provide a simply-constructed motor car which shall be durable under the severe strains to which they are subjected in mines, and which shall be capable of drawing over all of the ordinary grades and around the curves commonly met with, a load of large tonnage. The accompanying drawing shows the details of construction of the Dierdorff mine car, *A A* representing the track wheels, *B B'* the axles, and *C C'* the two sections of the body or platform.

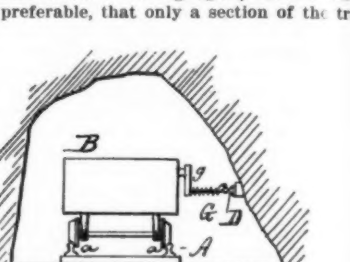


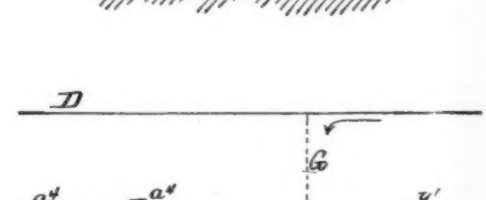
DIERDORFF ELECTRIC MINE CAR.

In 1897 an electric mining railway system was designed by William M. Schlesinger, an English engineer, using the tracks as a return for the current and a third conductor rail, above or at the side, designed to meet the difficulties of mine haulage, which he mentions as follows: "It is well known that the slopes, drifts, or gangways of mines are of limited space or area in cross section. They are more or less irregular in their outline and configuration in cross section and in their grade and direction. These gangways are the avenues through which the employes, animals, and materials used in and the products of the mines either pass or are transported to and from the same. The trackways in the slopes or drifts for the mule cars or wagons to travel upon are not laid with the care, accuracy, and solidity of surface roads, because it is unnecessary to do so, and, further, on account of economy. The disintegration of the rock or other material composing the walls of the gangways, due to natural and other causes, and the consequent falling of such material upon adjacent portions of the tracks in the gangway, to obstruct the travel or transportation thereon, are of more or less frequent occurrence. In repairing the roadbed and tracks in the gangways it is essential, as well as preferable, that only a section of the trackway be removed and replaced or repaired at a time, so as not to interfere with the movement of the cars from and into the mine, and the shifting of the empty or loaded cars from one gangway to another is a matter of necessity.



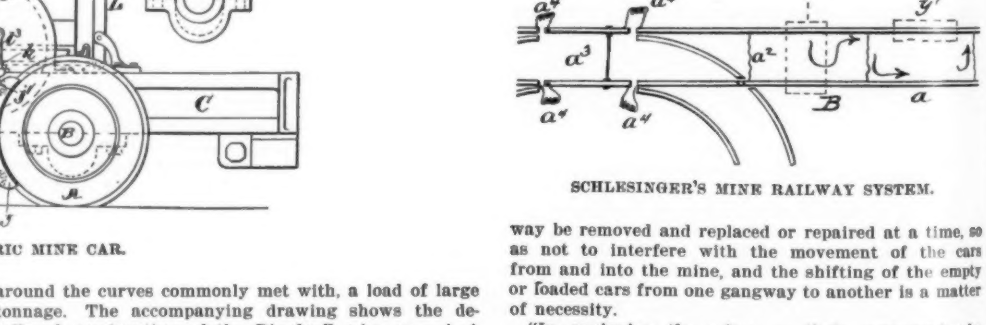
SCHLESINGER MINING RAILWAY.





SCHLESINGER'S MINE RAILWAY SYSTEM.

"In equipping the mines or their gangway-tracks with a system of electric-motor appliances for the cars, all of the above-described circumstances must be duly considered, in order to secure an electric railway system therefor, in which the economy of construction, efficiency and durability of its parts, and the provision of the utmost safety or protection for the employes and animals passing to and fro in the main gangway, and



SCHLESINGER ELECTRIC MINING LOCOMOTIVE.

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.

* Specially prepared for the Scientific American Supplement.

from the latter to other gangways in the neighborhood of the electric conductors, render it available for practical use and capable of being economically operated."

The electric mining railway system designed by Schlesinger overcomes the above objections, he claims, and he favors the third-rail system for supplying the current to the electric motors of the mining locomotive, the conductors being secured to one of the sides of the gangway or slope. The accompanying drawings illustrate the means employed for making contact with the conducting rail. A contact plow or current collector is employed, which rises and falls with the varying grade, and yields to the variations in lateral outline of a conductor, without breaking electrical contact.

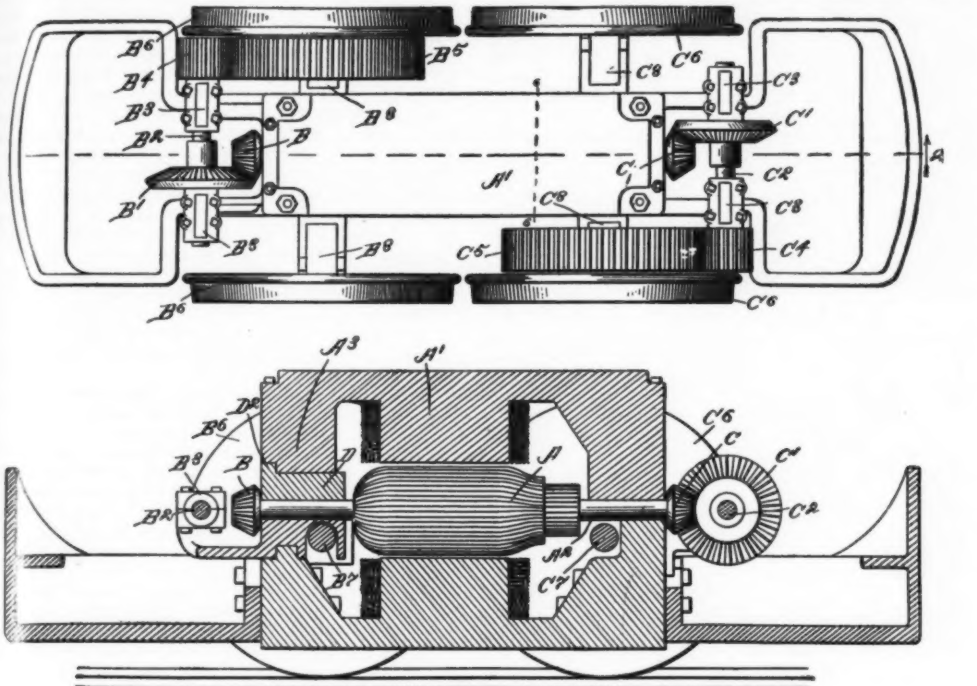
An electric mine haulage locomotive was designed in 1900 by Charles E. Davis, and another type by an English engineer, Mr. Cyrus Robinson, in 1901. The former mine locomotive, as will be noted by the drawings, has the electric motor armature operating parallel with the length of the truck, the wheels being driven by the electric motor through bevel and other gearing and connected by driving rods. The inventor states that in hauling in mines, the track upon which the locomotive must run is uneven, and hence only three of the driving wheels will rest upon the rails at one time as usually constructed. When this occurs, the tractive power of the locomotive is decreased, and other evils result, which he claims in his locomotive are avoided by constructing the axle of one pair of drivers so that it is free to move with the relation of the remaining parts of the locomotive.

The Robinson mine locomotive was designed for supporting the armature and field parts of the electric motor practically independent of each other, although held at a common place upon the frame connected to the axle.

The electric motor mounting differs in this way from those of other constructions, some of which have the armatures mounted directly upon the field-magnet frame, the latter being in turn mounted upon the axle or upon an interposed framework, while in others the armature shaft is mounted upon the interposed supporting frame, and the field magnet frame was more or less supported upon the shaft.

The illustrations and descriptions in our next number will show the latest types of mining locomotives constructed in this country at the General Electric, Baldwin-Westinghouse, Jeffreys, and Morgan works, as well as the German and Austrian mining locomotives built at the electric plants of Siemens & Halske in Berlin, Ganz & Co. of Budapesth, Hungary, and the Benrather Maschinenfabrik at Dusseldorf.

(To be continued.)



DAVIS MINE HAULAGE LOCOMOTIVE.

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.

THE HOSPITALIER ONDOGRAPH.*

By the Paris Correspondent of the Scientific American.

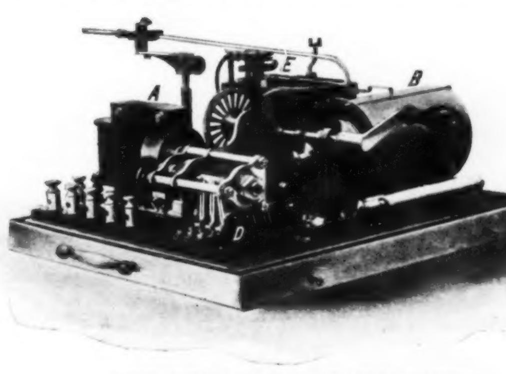
The question of tracing directly the wave forms of variable currents, and especially those of alternators and transformers, has always been of great interest; but up to the present there have been but few satisfactory instruments for this purpose. A great step in advance has been made by M. Hospitalier's new instrument, which he calls the "ondograph," or wave-tracer, and by a very simple and ingenious device he now obtains the waves directly upon a sheet of registering paper. Different forms of this instrument have been made, but the present form shown in the engravings is the one which has been finally adopted, and it is now manufactured on a commercial scale. The instrument works on a combination of the well-known Joubert method with a new device for shifting the contact progressively.

In the Joubert method, the alternator whose waveform is to be measured carries a contact point fixed to the armature shaft, and this contact strikes against a brush fixed to an exterior arm once in every revolution of the armature. These contacts are placed in the circuit of the alternator, and the successive impulses thus obtained are made to charge a condenser. This charge is read upon a static electrometer, and shows the difference of potential for a given angular position of the contact. By shifting the point of contact through different angular positions, a series of readings is obtained, and these can be plotted in order to give the wave form of the machine. If we suppose that the fixed arm carrying the brush, instead of being set in a certain position, can be given a slow and progressive movement from one side to the other, the contact would occur at a slightly different angular position at each revolution of the armature, and the difference of potential instead of being fixed, as in the former case, would take a regular fluctuation during this period. If the contact terminals are now connected to a condenser in parallel with an ordinary galvanometer, the condenser would receive a succession of variable discharges, and the needle of the galvanometer would swing slowly from one side to the other, passing through the zero point which corresponds to the zero point of the wave. By making the needle work upon a registering drum, it would trace a curve which corresponds to the curve of the machine if the conditions are properly carried out.

To realize these conditions in practice, M. Hospitalier uses the following device: The contact, instead of being mounted upon the machine, is driven by a small synchronous motor which operates upon the circuit to be measured. The contact device has the form of a small revolving commutator, which is driven from the motor by gearing. It is shown at *D* in the plan view, and also in the diagram. An ebonite cylinder, *H*, carries a brass tube, *I*, which is cut out as indicated. Three brushes, *L*, bear upon the different parts. At *G* is the galvanometer, and at *M* the condenser, while the circuit is connected at the terminals, *N*. At each revolution the commutator first charges the condenser from the circuit, and then discharges the condenser into the galvanometer. Supposing the commutator to revolve at the same speed as the motor, the contact would take place at each revolution at the same angular point, and thus the condenser would receive a succession of impulses having the same value. The galvanometer would take a fixed position corresponding to this value. However, the commutator does not revolve at the same rate as the motor, but it is so geared that while the motor makes *n* revolutions, it makes *n*—1 revolutions. In practice, while the motor makes 1,000 revolutions, the commutator makes only 999; so that the angular point at which the contact occurs is constantly varying during the 1,000 revolutions of the motor. This method of shifting the contact takes the place of the mechanical shifting which was first considered. In consequence, the charge of the condenser is constantly fluctuating during this period, and this charge is communicated to the galvanometer. The rate of fluctuation is made slow enough so that it gives continuous movement of the galvanometer, and the needle makes a complete swing back and forth during the 1,000 revolutions. The galvanometer, which is shown at *E*, to the right of the instrument, has a long needle which swings over a registering drum, and it thus traces the wave form by means of a pen.

The small synchronous motor, shown at *A*, is of the two-pole type and has its field excited by two storage battery cells. The armature, of the Gramme ring pattern, receives the alternating current by a set of collector brushes. A small transformer with variable tension plugs is connected in the main circuit and lowers the tension to 110 volts for the motor. To start the apparatus, the motor is brought up to synchronism by means of a handle which works a set of gears, and the handle is then taken off as in an automobile starting device.

The galvanometer is of the Deprez-D'Arsonval type, with a fine wire movable coil and a permanent horse-



THE HOSPITALIER ONDOGRAPH.

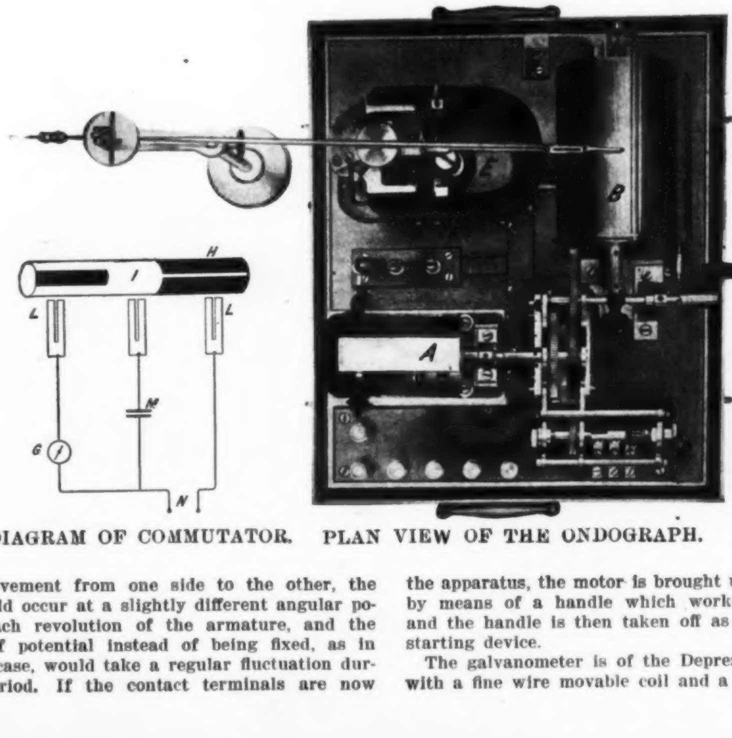


DIAGRAM OF COMMUTATOR. PLAN VIEW OF THE ONDOGRAPH.

* Specially prepared for the Scientific American Supplement.

shoe magnet. In order to register the wave form correctly, the galvanometer needle should move across the cylinder in a practically straight line, and, in order to diminish the arc, it is disposed as shown in the plan view. The galvanometer has a short needle attached to the movable part, while above and independently of it, is mounted a second and longer needle of aluminium, which is pivoted upon a heavy base outside the instrument, and provided with a counterweight. The galvanometer needle has a vertical pin, *F*, on the outer end, which works in a slot on the long needle, thus moving it back and forth, and the pen traces practically a straight line, as the swing does not exceed two inches. The mechanism which connects the drum with the motor allows it to register three complete wave periods during its revolution. The drum can carry a plain paper for simply observing the wave forms, or a strip of plotting paper for taking measurements. Each cycle is represented by an abscissa four inches long. At the rate of 40 cycles per second, the curve is traced in 25 seconds, and the paper moves under the pen at the rate of 0.16 inch per second. The current and potential force waves can be shown in their relative positions by first tracing one of the waves during the revolution of the drum and then, without disturbing the paper, the second wave is traced alongside of the first during the next revolution. In this way several waves can be traced upon the same paper for studying different phenomena.

A novel application of the instrument is in the registering of power or watt curves directly upon the cylinder, and this is the first instance in which such curves have been obtained directly. This will be of great help in determining the power consumed in certain apparatus, especially in transformers, and finding their efficiency. Here the galvanometer is replaced by the field coils and armature of a Thomson meter. The shaft has two spiral springs attached to it, which bring the current to the armature without using a brush. The main current passes in the fixed coils, and the armature is connected once per period and for a very short time in circuit with the electro-motive force to be taken. The commutator in this case is a simple brass bar placed across the cylinder and connecting the brushes. Under the influence of the successive impulses which the armature receives by the intermittent current passing in it and acting on the current in the fixed coils, it takes an angular position which is proportional to the power at each instant, and thus traces the power curve directly upon the registering drum. The proper inertia is given to the instrument by the copper disk working in a magnetic field which forms part of the meter, and the inertia is regulated to suit the requirements. To this form of the instrument M. Hospitalier gives the name of "puissance-graph" or "power-indicator," and he has been enabled to take a great number of interesting power curves of alternating current apparatus.

SOME DATA ON THE COST OF OPERATING AUTOMOBILES FOR COMMERCIAL PURPOSES.*

By Hiram Percy Maxim.

In the development of the pleasure automobile there have been reduced to practice four different motive power systems. They are the electric, with electric motors and storage batteries; the steam, with steam engines and boiler; the gasoline, with gasoline engines, friction clutch and change gears, and the so-called combination, in which a gasoline engine is coupled to an electric generator, which generates electricity, which is then used in electric motors as in the regular electric. Generally speaking, we may sum them up as follows:

The electric has arrived at what would seem to be a fixed and possibly final type. In all but the smaller pleasure vehicles it has two series of motors, independently connected, each to one of the driving wheels. The storage battery is carried below the body, between the axles and almost never inside a part of the body. All underlying principles necessary to successful operation in practical service are understood. A degree of certainty and reliability is assured, which enables the vehicle unquestionably to be placed among established transportation apparatus. The highest development unquestionably exists in this country.

In the case of gasoline, while we cannot say that one fixed arrangement has been reached, even in pleasure vehicles, several of the important elements have been reduced to an eminently practical point. The most important of these is the engine. In its best forms the gasoline vehicle engine has finally become a very trustworthy piece of apparatus. All of the principles underlying at least successful operation on the road are understood. For the first time its peculiar advantages for vehicle propulsion are made available. In the general arrangement of the vehicle some believe a final type has been reached, at least in the case of heavy vehicles. This type consists of a self-contained running gear frame, or chassis, which contains the entire power plant, controlling apparatus, and running gear. The engines are located in the extreme front end, in a compartment or so-called bonnet, entirely separate from the body-carrying space. They are connected through a friction clutch to a change gear device carried below the body. The connection thence to the driving wheels is through a differential.

In pleasure vehicle service a very satisfactory degree of reliability and certainty has been attained, notably in long-distance touring. In its best types it is probably no more than fair to class the vehicle among established transportation apparatus, since pleasure touring has come to be classed as a form of legitimate transportation.

In commercial vehicles no approach to anything standard or final has been reached. The highest degree of perfection in the system generally is usually conceded to have been reached in Germany and France, although last year's developments in this country make it a question if an equal degree of perfection has not been reached here.

There are in New York city to-day, approximately, three hundred electric wagons and trucks in service. This number of vehicles in operation has naturally brought out many important difficulties, as may be imagined. The most important of these is the cost of maintenance. Very vague, and in most cases entirely erroneous, ideas prevail upon this question. A careful consideration of it at this time and in this place ought to be a good thing. Not only should it serve to clear up some of the error and misunderstanding which exist, but it may also serve to furnish a basis from which to judge the possibilities of the other motive powers, a very interesting subject at this time and in this connection.

As already pointed out, the modern electric wagon is about uniform in general design. This even extends to the important details. Practically all wagons, for example, use the same kind of storage battery, and practically all of them use rubber tires. Not all of them, however, use the same amount of storage batteries or the same amount of rubber tires, and it is around these two elements that most of the popular misunderstanding and error exist.

Pains have been taken by the writer recently to go carefully into the general question of cost of maintenance. The object was not so much to determine the entire cost of operation of an automobile wagon and the saving of motive power over horse power, although this comes out as a natural sequence, but, rather, to determine the relationship between the different elements of maintenance expense as they exist to-day, and to estimate the probable effect of the various improvements we have at present in contemplation. An additional object was to compare the performance of wagons propelled by the other available motive powers, assuming the most recent developments in each were taken advantage of.

With this object in view, maintenance expense has been divided into six divisions, as follows: Battery maintenance; tire maintenance; cost of power; general repairs, which includes every repair other than those on battery or tires; depreciation, which includes the entire vehicle other than battery and tires; and interest on the investment.

In investigating the conditions existing in actual service many widely varying figures were encountered, as might be imagined would be the case in the present state of the art. An exact figure for any one element is probably an impossible thing to obtain. The best that can be done is to take an average of such observations as are known to be not entirely erratic, and to combine with this a certain amount of estimate based upon experience. The results represent a general performance which we know cannot be far wrong, and which, therefore, should serve very well for a consideration such as the present.

Taking the six elements of maintenance expense, the detailed data from which each has been made up, and which will be seen to contain many interesting facts, are as follows:

Battery Maintenance.—The same kind of storage battery is found in practically all vehicles. It is the Exide, a pasted lead battery made by the Electric Storage Battery Company, of Philadelphia. It represents the highest development of the light-weight lead storage battery to date. It is entirely reliable, as far as running is concerned, being virtually free from the old troubles of short circuits, buckled plates, and mysterious failures for which storage batteries have been notorious for years. Its separators consist of thin perforated sheets of rubber placed against each side of each positive plate, and a thin grooved wooden separator between these and each negative plate. The jar is of hard rubber, and in the latest types has ribs in the bottom which hold the plates some 1¾ inches up from the bottom, thus allowing for a large shedding of active material before enough has accumulated to make contact with the plates. The connections between cells have great strength, and ruptures and failures on the street on account of open circuits are very infrequent where anything approaching good care is given. Its one practical disadvantage, aside from cost, resides in its property of gradually shedding its active material.

The performance of this battery seems to be affected strongly, as far as maintenance expense goes, by the number of chargings it has to be given in order to perform the work it is called upon to do. For instance, all 2,000-pound capacity wagons, which is the general size used by department stores and for light express service, seem to have to make about thirty miles a day. All manner of theories and influences have been brought to bear upon this mileage question, but in spite of all thirty miles seems to be about what this size of wagon must average for a day's work if it is to be used to its full possibility.

Where a generous battery has been provided it does this with a reasonable factor of safety on one charge. This means, of course, but one charge a day, and a slow and advantageous one at that, on account of most of the night being available for it. On the other hand, where the battery has been scrimped, it is found to be impracticable in everyday service to always finish up a day's work on one charge. What is called a "boost" is necessary, and is given some time during the day. It consists usually in a short charge, and almost invariably a high rate one in order to get in as much as is possible in the short time which is usually available. This, of course, unavoidably increases the shedding effect on the positive plates, and, as is true in the case of all apparatus worked too near to its maximum limit, a shorter life results.

In a 2,000-pound capacity wagon for general service a twelve-plate MV size Exide express battery is a generous one, and since this represents disadvantageous conditions on the score of first cost, and is therefore conservative, it has been taken as the basis for these figures. The price of such a wagon with the usual type of department store body runs about $2,500 to-day. In ordinary service, and under the care-taking conditions existing in the general run of cases, a battery such as has been selected averages somewhere in the vicinity of ninety-five days' work before the shedding of active material, or "mud," as it is called, has accumulated to a point requiring removal. This removal is called its first cleaning.

A cleaning consists of cutting each connecting strap so that individual cells may be separated and the plates and separators as a unit removed from their rubber jars. When these are removed the jar is also removed and the mud washed out of it. Water from a hose is squirted generously over the element and down between the plates to remove all active material that may be lodged between the plates, and also to clear away all loosened active material from the plates themselves. This is done to each cell. They are then reconnected to each other, or burned, as it is called, and after filling with acid and given a long, slow charge are again ready for service.

After this cleaning they seem to run for somewhere about seventy-five days more before the mud has again accumulated to a point requiring another cleaning. This time the wooden separators have usually become defective by the acid to a degree which makes it necessary to remove them and to substitute new ones. This requires the separating of the element when it is removed from its jar, and means more labor and a greater breakage of rubber separators and plates than at the first cleaning. It also means the cost of the new wooden separators and the longer so-called "soaking" after the battery has been reassembled again.

When this has been done and the battery goes into service for the third time, it seems to be good for something in the vicinity of sixty more days' work before all of the active material on the positive plates has been shed and their useful life ended. When this point is reached a new set of positives is substituted for the old set, and since this means the handling of the fragile acid-soaked wood separators, these also must be substituted by new ones. This adds another element of rubber jar and separator breakage, a result principally of carelessness, but which evidently cannot be controlled, since it is universal.

When the new positive plates and the new wood separators have been installed, the battery starts out again entirely fresh, except for the negative plates. In most cases these seem to hold their own and to show no signs of failure until the next first cleaning. Furthermore, they do not appear to all fail together, as do the positives. At each cleaning it is apparent which are the ones likely to soon go, and the opportunity is taken at these times to remove them and substitute new ones. The death of the negative seems to be, in the ordinary service we are considering, a gradual breaking away of the active material from its support and a general disintegration of the entire plate. An average fully as bad as seems fair to take would appear to be one set of negative plates for every 1.67 sets of positive plates.

This, briefly, represents the detail of existing battery repairs. It amounts to a continual maintenance account, since the battery would under this arrangement be permanently in good running order. As already stated, the conditions named are average, and hence should be conservative. Taking now a full year's work, the cost per annum for such a battery performance as this amounts to the following:

New positive plates	$155.00
New negative plates	84.00
New wood separators	26.10
Rubber separators broken in handling	4.55
Rubber jars broken in service and in handling	21.70
Total labor in connection with battery	65.00
Supplies and other expenses	48.50
Total	$404.85

The wagon during this time has averaged about thirty miles a day. During the year there seems to be about 288 full working days for such a wagon. This means 8,640 miles for the year, which brings the battery maintenance expense to 4.68 cents a mile. This amounts to $1.40 a day.

The next item of maintenance expense is that of rubber tires. As in the case of batteries, a wagon on which the tires have been scrimped, and which are therefore working toward their limit all the time, wear out more rapidly than tires of more generous proportions. In a 2,000-pound capacity wagon a 3½ inch tire is a generous one, and since this also works disadvantageously on the score of first cost, and in consequence is conservative, it has been taken as the basis for these figures.

* Paper read before the Automobile Club of America, on March 22. This paper treats of electric, gasoline, steam, and gasoline-electric vehicles, those of the first two types being treated with great thoroughness, and much valuable information being given regarding storage battery maintenance and its cost on present-day commercial electric vehicles.

The price of a set of 3½-inch by 36-inch diameter solid rubber tires, allowing something for scrap salvage, is about $188. In New York city such tires can be depended upon for about 9,000 miles service. On the basis of 8,640 miles a year, the cost per annum becomes, for rubber tire maintenance, about $180. This is 2.09 cents per vehicle mile, or 62.7 cents a day.

The next item is cost of power or charging current. A good figure seems to be something in the vicinity of 14.2 kilowatt-hours per charge per day per vehicle. In many cases this charging current is taken from the regular lighting plant with which the stable or store is equipped. Where this is done the cost per kilowatt is very low, being never above 2 cents. When the current is purchased from the street mains, however, it amounts usually to something nearer 4 cents. A uniform figure of 3 cents has been taken for the purpose of this discussion. Upon the basis of 288 working days per year and 14.2 kilowatt-hours per day, the total power consumption for the year is 4,090 kilowatt-hours or 5,420 horse-power-hours. At 3 cents per kilowatt-hour, this comes out at $122.70 per annum, which is 1.42 cents per vehicle mile.

The next item is general repairs. As stated, this includes repairs of every nature other than those upon batteries and tires. It includes street collisions, side slewing repairs, and those resulting from the minor accidents unavoidable in service. Widely varying figures have, of course, been encountered in this also. An average has been taken and a constant arrived at which bears a relation to the price of the wagon, batteries and tires left out. This constant is about 4 per cent, and is convenient to arrive at the general repair expense of any vehicle, the service of which is about the average and the data of which is not obtainable.

In the modern types of wagons, having a thirteen-plate battery, 3½-inch tires, and a selling price of $2,500, the price, less batteries and tires, is, allowing for cells only in the case of the battery, $1,827; 4 per cent of this is $73.10, which is taken as an average for general repairs per annum for this size wagon. Per vehicle mile, it is 85 cents.

The next item is depreciation. An arbitrary figure of 10 per cent has been taken on the price of the vehicle, less batteries and tires. It is applied uniformly to all vehicles considered, and since the principal purpose of this discussion is the relationship of the different expenses, it is fair. The batteries and tires being constantly maintained, they must, of course, be excluded from depreciation; 10 per cent of $1,827 makes the depreciation charge $182.70 per annum, which is 2.12 cents per vehicle mile.

The last item taken is interest on investment. It is here that generous battery and tire allowance have their effect and serve to make the figures high, and therefore conservative. Five per cent is taken on the $2,500 price, which is $125 per annum, or 1.45 per vehicle mile.

The totals may now be taken. They stand as follows:

Battery maintenance	$404.85
Tire maintenance	180.00
Cost of charging current	122.70
General repairs	73.10
Depreciation	182.70
Interest on investment	125.00
Total	$1,088.35

(Or 12.61 cents per vehicle mile.)

It is interesting to note that this amounts to $3.78 per day, or, if 250 packages per day are delivered, it is 1.51 cents per package.

Before analyzing these expenses, let us look at wagons of a greater load capacity also.

The two heavy wagons which have been selected for this discussion are the three-ton and the five-ton trucks. The data concerning these are found in practice to be even more difficult to average than those of the small wagons. The less number of vehicles used and the greater variety of the service is the reason. The best that can be done in the way of an average figure is about as follows:

Battery Maintenance.—A generous battery for a hard-working three-ton truck is from 40 to 44 cells of seventeen-plate MV Exide express. For the same reason that a thirteen-plate battery is taken in the case of the 2,000-pound wagon, this seventeen-plate battery is taken as the basis for this three-ton wagon. This battery does a full day's work on one charge with a good factor of safety. The number of days' work it performs before its cleanings should therefore be the same as the battery in the smaller wagon. This seems to be the case, and brings the total life and number of days' work at about the same figure. The battery details per annum work out somewhere about the following:

New positive plates	$217.00
New negative plates	117.50
New wood separators	36.60
Rubber separators broken in handling	6.37
Rubber jars broken in service and in handling	32.80
Total labor in connection with battery	92.50
Supplies and all other expenses	67.80
Total	$570.57

The average day's work for a three-ton truck seems to run somewhere about twenty-four miles. The number of working days per year may be taken as averaging about the same as in the case of the smaller wagon, or 288. This brings the mileage for the year to 6,912, or, approximately, 7,000 miles. The cost per vehicle mile for battery maintenance works out from this at 8.25 cents. The average load in a three-ton truck all day long seems to be somewhere in the neighborhood of two tons in ordinary service. The yearly ton miles is therefore 13,824, which brings the battery maintenance out at 4.12 cents per ton mile.

Tire Maintenance.—A generous rubber tire for a three-ton truck is a 5-inch. Replacing a 5-inch tire on both front and rear wheels costs about $350 for tires. The life in average service is something in the vicinity of 8,000 miles. The yearly mileage being 6,912 for the vehicle, the cost per annum for tires works out at about $303, which brings the vehicle mile to 4.37 cents and the ton mile to 2.18 cents.

The next is charging current: As near as can be averaged, a day's charge for a three-ton truck is something like 20.5 kilowatt hours. This brings the power for the year to 5,904 kilowatt hours. At the rate selected, 3 cents per kilowatt hour, the cost per annum for charging current works out at $177.12, which is 2.57 cents for the vehicle mile and 1.29 cents for the ton mile.

The next is general repairs: Taking the 4 per cent figure, which is about as fair for this truck as for the smaller one, it is applied to the truck price, less tires and battery. The price of a complete three-ton electric truck averages to-day around $3,700. Batteries and tires taken out, leaves $2,672. Applying 4 per cent brings the per annum charge for general repairs to $106.88, which, for the vehicle mile, is 1.54 cents, and for the ton mile, 0.77 cent.

The next item is depreciation: Ten per cent on the price, less batteries and tires, becomes $267.20 per annum, which is 3.86 cents per mile and 1.93 cents per ton mile, quite an important item. In the case of the interest on investment, 5 per cent on the price of the vehicle brings the per annum charge at $185, which is 2.67 cents per vehicle mile and 1.39 cents per ton mile. The total of these three-ton figures, then, is something as follows:

Battery maintenance	$570.57
Tire maintenance	303.00
Cost of charging current	177.12
General repairs	106.88
Depreciation	267.20
Interest	185.00
Total	$1,609.77

(Or 23.2 cents per vehicle mile, or 11.6 cents for every ton mile, or $5.57 per day, which is a good figure from which to make comparisons.)

The five-ton truck is now left. This is the largest of all the electric automobiles which have been produced. In it a great many new difficulties are met with which do not appear in the smaller and lighter wagons. The cause is the much greater weight. The weight of a five-ton truck with its load is something of considerable magnitude when it comes to steering and driving it in ordinary street traffic. Physical exertion on the part of the driver and no little skill are needed for the steering alone. All of these things put together have caused more complaint to be made in the case of this vehicle than in any of the others, and more misunderstanding and error surround it also. Unquestionably the principal cause of this has been that the majority of five-ton trucks which have been placed in service have had inadequate batteries, tires, and motor. In neither of the other vehicles discussed does scrimping of these important elements have such serious effect. An endeavor has been made to confine the figures given here to those vehicles which have generous tires, motors, and battery proportions.

A generous battery for a five-ton truck is forty-four cells of nineteen-plate MV Exide express. Such a battery is usually able to manage a full day's work on one charge, and, as such, requires cleanings on about the same basis as the other vehicles which have but one charging a day. The battery maintenance expenses per annum on this basis may be taken as something about as follows:

New positive plates	$244.00
New negative plates	132.00
New wood separators	41.00
Rubber separators broken in handling	7.15
Rubber jars broken in service and in handling	35.00
Total labor in connection with battery	102.00
Supplies and all other expenses	75.00
Total	$636.15

The average day's work for a five-ton truck seems to be about twenty miles. The number of working days per year, as in the case of the other wagons, may be taken as about 288. This brings the mileage run in one year to 5,760, making the battery maintenance 11.05 cents per vehicle mile and 3.15 cents per ton mile, since the average load of a five-ton truck all day long seems to be something about three and one-half tons. It is interesting to see that this means the total accomplishment in a year of 20,160 ton miles.

In the case of the tires, a generous rubber tire for a five-ton truck is 7-inch on the rear driving tires and 6-inch on the front tires. These have been found to give very satisfactory results even in the severe service of the five-ton truck, and it may be mentioned here that this service is extraordinarily severe, as compared with that of smaller vehicles, on account of five-ton trucks being principally used in downtown districts, where pavements are very bad.

These tires cost somewhere about $464 per set. Their life in average service is something in the vicinity of 7,680 miles, as near as an average figure can be taken. The yearly mileage being 5,760, the cost per annum for tire maintenance works out at $348, or 6.05 cents for every mile run and 1.72 cents for every ton hauled over one mile of distance.

The charging current for a day's charge is something like 21.6 kilowatt hours on an average. This is 6,220 kilowatt hours, which at 3 cents, brings the annual charge to $186.60, which means 3.24 cents for power for every mile run and 0.92 cent for every ton hauled a mile.

On the score of general repairs, the 4 per cent figure holds as well as on the smaller vehicles. The price of a complete five-ton truck to-day approximates $4,000. Batteries and tires taken out, leaves $2,785. This amounts to $111.40 per annum, or 1.93 cents per mile run, or 0.54 cent per ton mile.

In the case of depreciation, the 10 per cent constant amounts to an annual charge of $278.50, or 4.84 cents per mile run, or 1.38 cents per ton mile. The interest, at the 5 per cent figure, is no less than $200 per annum, which is 3.46 cents per vehicle mile and 0.99 cent per ton mile. These, totaled, appear as follows:

Battery maintenance	$636.15
Tire maintenance	348.00
Cost of charging current	186.60
General repairs	111.40
Depreciation	278.50
Interest	200.00
Total	$1,760.65

(Or 30.57 cents for every mile run with average load on board, or 8.75 cents for every ton which is hauled a mile. It is interesting to note that this totals $6.11 a day.)

Now for some convenient way to get a comparative judgment of these different figures. In order that they may all be seen at once, they have been tabulated, as shown in table No. 1.

TABLE NO. 1.

Relation between elements of cost of maintenance in existing electric vehicles:

	1-ton wagon.		3-ton wagon.		5-ton wagon.	
Elements.	Veh. mi.	Per cent.	Veh. mi.	Per cent.	Veh. mi.	Per cent.
Battery	4.68	37.0	8.25	35.4	11.05	35.5
Tires	2.09	16.6	4.37	18.8	6.05	20.0
Depreciation	2.12	16.8	3.86	16.6	4.84	16.0
Interest	1.45	11.5	2.67	11.5	3.46	11.4
Chg. current	1.42	11.4	2.57	11.0	3.24	10.7
Repairs	.85	6.7	1.54	6.7	1.93	6.4

Totals $3.78 per day, $5.58 per day, and $6.11 per day.

From this table we are able to see that a general average of the majority of the vehicles of up-to-date proportions in actual service to-day, have six important items in their operating expenses which amount to quite a considerable sum of money. This brings us unavoidably to a comparison with the corresponding costs when horse power is used. While it is not intended to dwell upon this matter, it may be well to touch upon it while passing.

(To be concluded.)

KOREAN HOUSES.

THE Rev. C. T. Collyer read a paper on Korea at a recent meeting of the Royal Geographical Society. He said the winter cold is very intense, and during cold weather the Korean will not leave his house unless obliged to. When building it he always looks for a sheltered spot, and plans the house so as to get in it the maximum amount of heat. Never, said Mr. Collyer, is a house to be found on the north side of a hill or mountain, and there is no location so desirable for house building as under the lee of a horseshoe-shaped hill facing the south. In any village the houses that are highest up on the hillside are always the poorest. They are all one-story buildings, and that story is but a low one. Their rooms are supposed to be perfect cubes of 8 feet, though it is generally found, to the distress of tall people, that the tie-beams of the roof come within 6 feet of the floor. The roof which, with the exception of those in the cities, is generally thatched with rice straw, is entirely supported by pillars, which rest on foundation stones laid on, not set in, the ground. The spaces between these pillars are filled up with what we must call laths and plaster partition, according to the material that is found locally. The floor is of stone slabs laid over flues in which brushwood grass, or other fuel, is burned. The stones, thus becoming heated, radiate their warmth through the entire room. So as to lose none of this warmth, the Korean uses no furniture. This floor, with its oil-paper cover, is to him chair, table, and bed. The Korean, as an individual, differed largely from the Chinese or Japanese. He desired, most of all, the peaceful life of a student. When placed in the schoolroom with Chinese and Japanese students, the Korean had always shown himself to be, from an intellectual point of view, superior. Casual visitors had branded him as lazy and indolent, but the truth lay in the fact that he lacked incentive through official oppression. The principal exports were rice and beans to Japan, ginseng to China, and gold, which was now almost exclusively purchased by Japan. Gold was found in paying quantities in many parts of the country; the oldest established mine where Western methods were in use was in Ping-Yang, where the American mine had proved to be a perfect bonanza. The Koreans might be fairly compared to a sleeping man. For three centuries they had been asleep, unable to shake

off the lethargy produced by the shock of the Japanese invasions, when all her skilled workmen were deported; the art pottery of Japan was the outcome of the work of the descendants of the Koreans. At the present time the Korean was surprised to hear the snort of the locomotive pulling a train across the valleys and through the hills, and was astonished to see the electric tram go past him in the streets of his capital. Mr. Collyer had had some experience of taking Koreans from the country into Seoul to see the modern improvements; they had invariably been speechless until returning to their native hamlets, where they were free to describe what they had seen. Throughout the country the telegraph wires had been stretched for the past ten years, and now this was superseded by the telephone. The introduction of the railway, electric trams, electric lighting, telegraph, and telephone was appreciated, and was working great changes in the thought and habits of the people.

[Concluded from SUPPLEMENT No. 1476, page 23655.]

THE RECENT VOLCANOES OF SOUTHWESTERN IDAHO AND SOUTHEASTERN OREGON.*

By ISRAEL C. RUSSELL.

JORDAN CRATERS.

IN the east-central part of Malheur County, Ore., and from 18 to 20 miles west of the Idaho-Oregon boundary, there are four recently extinct volcanoes, which are here termed, collectively, the Jordan Craters. They are situated to the north of Jordan Creek, and to the west of its tributary known as Cow Creek. The four craters referred to are nearly on a line bearing a little west of north and are approximately 3 to 5 miles apart, although the distance of the one at the north from its next neighbor is somewhat greater than the spaces between the others in the series. While but four recent craters are here referred to, there are certain rounded hills to the west of the south end of the series which are probably of volcanic origin, and perhaps represent ancient craters, but these have not yet been examined.

Three of the four craters referred to—that is, all but the most northerly in the series—are situated in a valley, and the lava which flowed from them spread in all directions and built up lava cones with broad bases and low surface slopes. Each crater rises about 500 feet above the plain, but by far the greater part of this elevation is gained in the broad, low lava slopes surrounding the small buttes which mark the centers of eruption. The central elevations are in general about 150 feet high, and are composed of lava which occurs mostly in thin sheets. There is an absence of scoria in detached clots and of lapilli or other ejected material, such as is blown into the air during explosive eruptions. In short, they are elevations formed by the cooling and hardening of lava which overflowed from the summits of volcanic conduits in all directions so as to form low cones with immensely expanded bases. When seen in profile, especially at sunrise or sunset, they are at once recognized as typical examples of what I have ventured to term lava cones in distinction from elevations built by the accumulation of projectiles.

The central and summit portion of each of the Jordan Craters is usually circular, with steep outer slopes, and in one instance contains a crater-like depression. This cavity in the summit of the cone, as in the case of many similar lava cones in Idaho and Oregon, is due to the falling in of a dome-like structure composed of thin lava sheets, the subsidence being caused by the escape of still liquid lava laterally from beneath a rigid crust.

FIG. 8.—DRIBLET CONE OR OVEN, JORDAN CRATERS, OREGON.

FIG. 9.—DRIBLET CONE, DIAMOND CRATERS, OREGON.

It is convenient to designate the Jordan Craters by numbers, beginning at the south end of the series and proceeding northward. A brief examination serves to show that No. 1 is the oldest in the series; next in age is No. 3, then No. 2, and last and youngest of all, No. 4. Their relative ages are shown by the degree to which their surfaces are weathered and the extent to which they are covered with soil and vegetation. The slopes of the oldest crater are smooth, with but few rocky crags visible, and are covered with soil mostly of eolian origin, in which a strong growth of sagebrush, etc., is conspicuous. Crater No. 3 is less completely concealed beneath accumulations of atmospheric dust than No. 1, and is less densely overgrown with sagebrush, while No. 2 presents a rough surface of hard black lava, on which pressure ridges are conspicuous, although notable quantities of atmospheric dust have accumulated in the depressions, and bushes and bunch grass grow in cracks and crevices on seemingly bare cindery crags and ridges.

While Craters Nos. 1, 2, and 3 are instructive on account of the many square miles of lava poured out from them and the various stages reached in its change to smooth pasture land, the chief interest of the general locality centers about Crater No. 4, at the north end, the youngest of the series.

FIG. 10.—LAVA GUTTER, JORDAN CRATERS, OREGON.

Crater No. 4.—This very modern crater, unlike its companions, came into existence on a somewhat steep-sloping hillside, which was trenched by erosion channels previous to the volcanic outburst, and the great flood of extruded lava flowed away in one principal direction. Owing to the freedom afforded for the escape of the lava down the slope below the orifice from which it came, a large portion of the cinder and lapilli crater, built during an early stage in the history of the volcano, has been spared, and furnishes important evidence as to the general sequence of events, which, as it now appears, normally accompany the building of lava cones.

Crater No. 4, as it exists to-day, is in part a cinder and lapilli cone, and in part a lava cone, and extending over an area of about 50 square miles on its southeastern side is a black lava field entirely bare of vegetation. Although differing conspicuously in its details from the associated craters in the same series, the one here considered was evidently built in the same manner as its companions, but owing to its being located on a sloping surface, the products of the earlier stages of the eruption which built it were not buried by the great effusion of highly liquid lava poured out later, as was the case in numerous observed instances, where similar eruptions have occurred on a plain.

Throughout about one-half of the periphery of the cinder and lapilli cone forming Crater No. 4, the older rocks, consisting mainly of Tertiary rhyolite, are without a covering other than a thin layer of soil, to within a distance of 800 or 1,000 feet of its base. This fact suggests that some evidence may perhaps be obtainable as to the nature of the break or opening through which the eruption that built the crater reached the surface. The testimony in this connection, however, is meager. On the hillside, where the crater is situated, and extending in an essentially straight line from it, both to the north and south, there is a faint escarpment averaging perhaps 15 feet in height, and facing east. This escarpment has the general appearance of a fault scarp, but is by no means certainly of that nature. The only unquestionable evidence of a break in the rocks on which the crater stands is furnished by a row of about 12 driblet cones, situated in a line extending west from the principal center of eruption and up the slope of the hill at right angles to the faint escarpment referred to above. The portion of the break on which the driblet cones are located, situated at a distance of about 1,000 feet from the center of the main crater, shows no evidence of a differential movement of its walls. There is then but slight evidence of a shattering or faulting of the country rock preceding or following the birth of the volcano.

The portion of the original pile of cinder and lapilli remaining at Crater No. 4 is highest on the south side of the crater, where it rises about 100 feet above its outer base and somewhat more above the irregular pit it partially inclosed. The cone has lost much of its symmetry, owing to the falling of its inner surface, and on the south side of the crater presents a fairly good section of outward-dipping layers of lapilli and of compact reddish lava. The compact layers referred to are among the more interesting features of the section, and while having the appearance of lava flows which descended the outer slope of the lapilli and scoria cones when it was but partially completed, are in reality due to the flowing together and cooling in one mass of many splashes of liquid lava. This mode of origin of the dense compact layer is shown by its containing angular fragments of lapilli and by small, isolated, lenticular masses of the same nature completely embedded in lapilli, with which it forms a complete gradation. More than this, the surrounding surface of rhyolite, adjacent to the base of the cinder and lapilli cone, where not concealed beneath lava flows, and to a distance of about 800 feet, is thickly strewn with reddish clots of lava, which were liquid when they fell and in general ran together, so as to form a tide-like sheathing to the surface. This material spattered out of the crater, and falling well beyond, its base is of the same character as the layer of dense lava built into its wall and covered by subsequent showers of lapilli. The preservation of the rough, angular pavement, composed of congealed splashes of lava about the crater, which fell in a liquid condition, thus serves to explain the history of at least

* Extracted from Bulletin 217 of the U. S. Geological Survey.

certain compact layers in the walls of the cinder cone, the most noticeable of which has a thickness of between 10 and 20 feet. Similar compact, usually reddish, layers of lava in cinder cones have been observed at the Cinder Buttes and elsewhere, as already explained, and are evidently a common feature of the walls of cinder and lapilli craters built by volcanoes which discharged highly liquid lava.

After a small cinder and lapilli crater had been built by the volcano under discussion, it is evident from the records still remaining that liquid lava rose within it and breached its wall, both on its west and southeast borders. The lava which escaped westward was small in amount and now forms a pool-like sheet of black pahoehoe about 600 feet across. Some of the lava in this pool, however, came from the crack mentioned above, along which there is situated a row of driblet cones. After the opening of a breach in the west side of the crater, the opening was partially closed by a discharge of lapilli, but not rebuilt to its former height. On the southeast side of the crater the portion of its wall which has disappeared includes about one-third of its original extent, and through the break there was outpoured a flood of lava which inundated an area of about 50 square miles. The lava cooled in the breach it had formed in thin sheets, so as to produce a steep-sided ridge, which completely occupies the break and unites with the remaining fragments of the lapilli and cinder cone at each end. This ridge of lava is of the same nature as the walls of typical lava cones, being formed of thin sheets of highly vesicular rock, each one seemingly formed by the congealing of a thin overflow from the crater and succeeded by another similar overflow, until a steep ridge composed of overlapping lava sheets was produced. The main discharge of lava took place beneath the crust thus formed, after the manner so common in highly liquid lava streams, and escaped through tunnels.

The final drawing off of the molten material, which once filled Crater No. 4 up to the level of the top of the rim of congealed lava on its eastern side, allowed the crust of scoriaceous and ropy pahoehoe lava formed within it to subside, and, although in part broken, it still rests at the bottom of the irregular pit it left, about 100 feet lower than its former position. Since the subsidence of the floor of the crater, there has been some tumbling in of its unsupported walls, but the cakes of corrugated lava on its floor are still to a large extent unconcealed.

The rise of liquid lava within a cinder and lapilli cone, as in the example just described, the building of a raised rim in the breach in the crater walls composed of fragmental material, and the subsequent lowering of the lava crust formed on the pool within the crater, are all features which are found in Idaho and Oregon in numerous volcanoes which built lava cones. The greater number of the lava cones that have been examined, however, are situated on generally plane surfaces, and the floods of outwelling highly liquid rocks, which were extruded from them, spread in all directions, and the cinder and lapilli cones, which probably in all the instances referred to were formed at an early stage in the eruptions, were completely destroyed or buried. In the instance here considered, however, owing to the inclination of the surface on which the volcano originated, the lava extruded flowed almost entirely in one direction, leaving a large portion of the preceding cinder and lapilli cone intact. No. 4 of the Jordan Craters is thus in part a cinder and lapilli cone and in part a lava cone. Had the scope down which the lava flowed been steeper, it is probable that the liquid rock would have flowed away too quickly for a lava ridge to have been formed about the pool in the summit of the conduit from which it came, a condition illustrated by the Martin lava stream and other similar outwellings of lava in mountainous regions described in Bulletin No. 199.

FIG. 11.—LAVA GUTTER, JORDAN CRATERS, OREGON.

Driblet Cones and "Ovens."—The extrusion of liquid or highly plastic lava from cracks or other openings in the crusts formed on lava, as in the craters of certain of the Hawaiian volcanoes, has been described by J. D. Dana,* and the hollow cones, towers, etc., produced by drops or clots of ejected material which adhered one to another, have been designated driblet cones. Interesting examples of structures of this general nature occur along the fissure mentioned above, which extends westward from the most northern of the Jordan Craters.

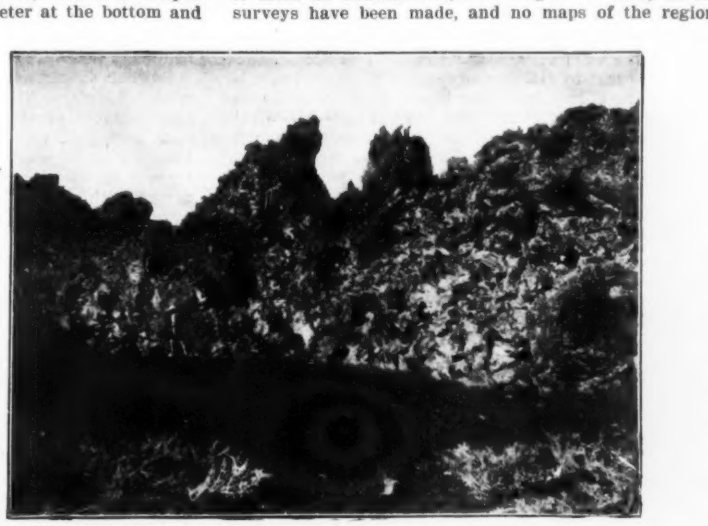
Situated on the fissure referred to are 10 or 12 oven-shaped piles of lava clots, some of which are more or less confluent, so that a definite count is impracticable. These piles are nearly circular, with rounded summits, and range in height from 15 to probably 25 feet, and are hollow within. Some of the examples are still unbroken, and are either completely roofed over or have rudely circular openings at the top, while others are broken and prevent free examination of their interiors. One characteristic example, shown in Fig. 8, is about 20 feet high on the exterior, between 40 and 50 feet in diameter at the base, and within contains a symmetrical level-floored chamber, with dome-shaped roof, measuring 14 feet in diameter at the bottom and 17 feet in height. The walls of this "oven" are about 12 feet thick at the base, and diminish gradually toward the roof, which is from 4 to 6 inches thick. This beehive-like pile, and others similar to it, are plainly of the nature of driblet cones, but on account of their shapes may perhaps be termed driblet ovens. Their formation, as has been explained by Dana in reference to similar structures observed in the Hawaiian Islands, is due to the blowing out of plastic lava from an orifice and the piling up of the adhering clots about the place from which they came. The hollow chimney-like forms thus produced were gradually contracted at the top until, in some instances, they became completely roofed over. On the interior of these structures the lava hangs in pendent, stalactite-like masses, usually of a deep-reddish color, and from a few inches to 2 feet or more long.

Examples of similar driblet cones of smaller size occur on a lava flow that came from the Diamond Craters, to be described later, two of which are shown in Fig. 9. Driblet cones are also present at the Cinder Buttes, but in this case are chimney-like piles, termed on a previous page parasitic cones. One example at the Cinder Buttes, however, now partially destroyed, has the oven-like shape so characteristic of the example present at the Jordan Craters.

Lava "Gutters."—About the bases of the driblet ovens associated with Crater No. 4 of the Jordan series, and also at the east base of the crater itself, there are localities where lava flowed in narrow streams down moderately steep slopes and made for itself well-defined channels. These channels are, in general, about 3 feet wide, 3 to 4 feet deep, with the crests of their bordering ridges elevated about 3 feet above the adjacent surface, and from 50 to 150 feet long. One example of these troughs or gutters, situated at the south base of the driblet cone shown in Fig. 8, is about 50 feet long, 14 to 16 inches wide, and 3¼ to 4¼ feet deep; the crests of the bordering ridges are, in general, 3 feet above the adjacent surface. Near its distal extremity the trough is completely roofed over, as may be seen in the illustration just referred to. The largest example observed is situated on the east side of Crater No. 4, and is about 150 feet long, 3 feet wide, with well-defined walls, which rise approximately 3 feet above the neighboring surface. These and other similar gutters usually begin abruptly at their upper ends and retain a nearly uniform width and depth to near their distal extremities, where their walls become lower and the troughs merge with broadly expanded, low, dome-shaped elevations on a general pahoehoe surface. In some instances the liquid lava, as it flowed through one of these gutters, became cooled at the surface so as to form a crust, which was left as a slightly arched roof above a tunnel as the still liquid lava beneath flowed out. These gutters with roof are in fact tubes or tunnels. In the instance shown in Fig. 10, a well-defined gutter was formed, in which the lava flow decreased until the surface of the current was about 3 feet below the crest lines of the inclosing ridges; a crust was then formed, and the lava below it flowed out, leaving a roof spanning the gutter throughout its length.

The mode of formation of lava gutters seems to be that a narrow stream of liquid lava cools at its margins and forms a slight ridge. More lava spreading laterally over this ridge, in turn cools and stiffens, and then adds to its height, and so the process continues until a well-defined gutter with raised borders is formed. These parallel ridges on the borders of a narrow, high-grade lava torrent are, in a measure, analogous to the natural levees built by alluvial-depositing streams.

Lava Flow.—The lava from Crater No. 4 of the Jordan series, as already stated, flows southeastward over a previously stream-eroded surface. The lava, just after leaving the crater from which it came, formed a stream 545 yards wide, and increasing rapidly in width reached a distance of about 8 or 10 miles. The entire flow is by estimate between 50 and 60 square miles in area. The average depth may perhaps be taken as approximately 100 feet. These statements, it must be remembered, are rough estimates, as no surveys have been made, and no maps of the region are available. The lava, as it advanced, was guided in a conspicuous way by the pre-existing topography, and in several instances progressed short distances up lateral valleys tributary to the main depression down which it flowed. One of these small offshoots went nearly due north for one-half mile up a small stream valley until its progress was checked by the rising gradient. In places the fresh, black lava is bordered by rims of older rock, showing that small canyons in the pre-existing surface had been nearly filled. Near the eastern limit reached by the lava it



FIGS. 12 AND 13.—MARGINS OF LAVA FLOWS, CINDER BUTTES, IDAHO.

* Characteristics of Volcanoes, New York, 1890.

ascended the small canyon of Cow Creek for about 1 mile, and on cooling formed a dam, which now retains the largest and most northern of the Cow Creek lakes, as has been described on a previous page. About its southeastern margin there are several other lakes.

This great lava stream or lava sheet came from a small crater, termed above Crater No. 4, the bottom of which is approximately 300 feet across. Seemingly the actual conduit must be of still smaller diameter. This effusion of highly liquid lava, with only mild explosions at the beginning of the discharge, is a typical illustration of the manner in which many extensive lava sheets of Idaho, Oregon, and Washington were poured out. The lava from Crater No. 4 seems to have progressed mainly by flowing beneath a stiffened crust, and in this manner was prevented from cooling quickly, thus permitting it to advance far and spread widely. Tunnels in the lava were produced by the outflow beneath the crust formed on its surface, and in certain places, as near the source of the stream, the roofs of such tunnels have fallen in, leaving irregular pits with overhanging walls from 50 to 70 feet deep.

In many portions of the lava flow pressure ridges and domes like those so common in the immense lava sheets about the Cinder Buttes, in the older sheets of Snake River lava, and at other places, are well displayed.

DIAMOND CRATERS.

A group of recently extinct volcanoes which it is convenient to term the "Diamond Craters" is situated in the east-central part of Harney County, Ore., about 6 miles west of Diamond post-office. The craters, about twenty in number, occupy an area of about 5 square miles, and are surrounded by at least 30 square miles of rough lava which flowed from them.

The Diamond Craters are situated near the base of the long west slope of Stein Mountain, and came into existence after the land over which they discharged their lava had been deeply dissected by erosion. The lava entered the valleys and canyons and obstructed the drainage so as to cause swamps to form. A significant fact is this connection is that the basins above some of the lava dams are still unfilled and have never been occupied by water bodies except ephemeral or playa lakes. This evidence seems to show that the climate of the region has been as arid as at present ever since the lava streams obstructed the drainage.

The Diamond Craters are of two types, namely, lapilli cones and lava cones, the lapilli cones situated in the southwest and the lava cones in the northeast portion of the group. The lapilli craters are mostly low, and range in size from one measuring about 2,500 feet across to small conical piles of brownish *débris*. Within the largest crater there are hills and mounds of lapilli of the same character as the material forming its encircling rim, but rising to a height of from 50 to 75 feet above it. This great accumulation of fragmental material presents an uneven surface consisting of hillocks and crater-like hollows and bears evidence of the occurrence of weak explosions in a crater so abundantly charged with *débris* that it could not clear itself. From analogy with streams, the volcano may be said to have been overloaded with *débris*. The fragmental material was blown up into hills, and crater-like pits opened in it, but the escaping lava did not have sufficient force to eject it from the crater.

The hills and rings of lapilli among the Diamond Craters present many variations. Some are simple conical piles of the normal type, with depressions in their summits; in others lava rose and, breaching the inclosing wall, overflowed. In one instance the lava, after rising in a crater and outflowing, was drawn off beneath the crust formed on its surface and within the bowl of lapilli, about 600 feet across, causing the crust to fall in and leaving a black, irregular gulf 30 feet deep, and one lapilli ring or crater has another, composed of the same kind of material, within it, thus recording two stages of activity. In one instance a small crater is composed of compact, spherical lava balls or bombs, ranging in size from about 2 inches to the size of small shot. These bombs are rough, of a dull-red color, not cellular, and exhibit no evidence of rotation excepting their well-rounded shapes. Bordering the lapilli craters on all sides are the broad, rough surfaces of recent lava fields, which in most instances are covered to some extent with sagebrush and other vegetation.

To the north of the lapilli craters and merging with them as topographic forms are rounded hills composed of lava sheets, which furnish examples of lava cones. The highest of these hills rises about 400 feet above the adjacent plains and is the highest and most conspicuous summit in the group of which it is a member. This central dome is about 1½ miles in diameter, and, so far as is indicated by the exposures, is composed throughout of lava sheets, which occupy its summit and descend its sides in all directions to the surrounding plain. There is no true crater to be seen, but at the summit of the hill there is a gulf, due to the falling in of a large block of lava of which the surface of the hill is composed. This gulf has a nearly vertical wall from 40 to 70 feet high, runs about east and west, is from 500 to 800 feet across, and fully 2,000 feet long. Within it are several irregular ridges formed by the edges of large tilted blocks of the fallen crust. The lava exposed in the walls of the break is irregularly columnar, and the topmost layer, which arches over the summit of the hill, is about 40 feet thick. This sheet is continuous from one side of the hill to the other, passing over the summit, but in the central part of the dome thus formed the rock is highly scoriaceous and the bedding less distinct than at the sides. From the gulf in the summit of the hill branching fractures extend down its sides to east and southeast, and in part these radiating breaks are gulfs produced by the subsidence and tilting of large blocks of the surface layer. To the north of the hill just described there are other elevations of a similar nature, but lower and less broken, and about the group there are rough lava flows, which came from it and spread over the previously eroded land. On one of these lava sheets there are small driblet cones, two of which are represented in Fig. 9.

The interpretation of the facts in reference to the domes of lava briefly described above seems to be that from certain of the Diamond Craters, which were probably lapilli cones like those of that nature still remaining, great quantities of lava were extruded in a liquid or plastic condition, which buried or carried away the preceding craters of lapilli and, thickening about the opening from which it came, built up rounded hills. The outwelling lava flowed down the sides of the hill and a thick crust was formed on its surface. After this, the outflow continued beneath the stiffened surface, and finally, when no more lava rose from the conduit beneath, a considerable portion of the surface crust fell in, leaving the black gulf now forming such a conspicuous feature of the summit and eastern side of the largest dome. The smaller lava cones or domes to the north of the principal cone were less fractured than the main one of the series, and retain nearly all of their constructional features unmodified by either fracture, subsidence, or erosion. In fact but slight changes by erosion are anywhere visible throughout the entire group of craters.

The rounded hills of lava among the Diamond Craters are, as may be judged from the description just given, examples of lava cones, and are similar to many other elevations in Idaho and Oregon, which were produced in each case by the escape of lava in large volume from a volcanic conduit. The chief differences between the lava cones here considered and those of the normal type are the prominence of the rounded central hills and the comparatively small extent of the surrounding lava fields with which they merge. The usually characteristic profile presented by lava cones, consisting of long, gentle slopes leading up to a low central flat-topped butte, is not present. In this connection it may be suggested that the lava poured out to form the hills referred to was less liquid and did not flow away so readily, as in many other similar instances, but thickened in a more conspicuous manner than normally about the openings from which it came.

In the formation of lava cones, as is the case with the flow of lava streams generally, an important condition, and the one which makes it possible for a small hill to form with a sheet of lava extending completely over its summit, is the subsurface flow of liquid or plastic lava beneath a stiff crust. The degree to which lava escapes in this manner from a deep accumulation determines the extent to which its surface will be fractured and the amount of surface change which will result from the subsidence of fragments of the crust.

BOWDEN CRATER.

Situated in the south-central part of Malheur County, Oregon, and about 6 miles northeast of the former post-office of Bowden, there is an isolated volcanic crater surrounded by an extensive lava flow, which it is convenient to designate the Bowden Crater.

The region about Bowden Crater is composed largely of Tertiary lacustral deposits, and was deeply eroded before the eruption which built the crater. The region, in fact, had all of its present erosion features at the time referred to, and has been but slightly modified since the volcano ceased to be active.

Bowden Crater and the lava flow about it are composed of basalt. There is, so far as observed, a complete absence of the products of explosive eruptions, such as lapilli, volcanic bombs, etc. The crater rises 600 feet by aneroid measure above the plain at the margin of its lava flow, but the lava flow and crater merge with each other, and the rise from the outer margin of the lava to the base of the cone in the center of the broad, black, desolate tract of fresh rock is exceedingly gradual. The upward slope for the first 3 or 4 miles is less than 1 deg.; then for about 2 miles it gradually increases to perhaps 2 deg. or 3 deg., and on the sides of the central and circular elevation becomes about 10 deg. The height of the central elevation above the surrounding lava is approximately 200 feet. The walls of the crater are of lava of the same general character as that forming the extensive sheet about it, but are perhaps somewhat more scoriaceous. The raised rim of the central elevation inclosed a steep-sided circular basin, 600 feet in diameter and about 40 feet deep. The bottom of the depression is level floored and consists of fine light-colored silt, most probably of eolian deposition. During the wet season this depression is converted into a shallow lake, which evaporates to dryness in summer.

When standing on the summit of Bowden Crater no other similar elevation is in sight, and no other volcanic vent has as yet been discovered nearer than the Jordan Craters, situated about 30 miles to the northeast. It is thus evident that the surrounding lava flow came entirely from this single and relatively small center of eruption. The lava flow referred to surrounds the crater on all sides, but extends farthest to the northwest, or in the direction of the drainage of the region before the lava was spread out. The area of the lava field is by estimate fully 100 square miles. The thickness, on the supposition that it was spread out on a nearly level plain—which was apparently the case—varies from but a few feet at the margin to about 400 feet at the center. The surface of the lava is rough, and many pressure ridges are present, particularly within a radius of 2 to 3 miles of the crater. Considerable weathering has occurred, and in general the entire lava flow, as well as the sides and bottom of the crater, is overgrown with sagebrush, bunch grass, and other vegetation. On its southern border the lava field dammed Rattlesnake Creek, and caused a lake of considerable size to form. The bed of this lake has been filled to a depth of at least 40 feet with fine alluvium, and, owing in part also to the lowering of its outlet by erosion, is now dry and occupied by natural meadows of rye grass.

Bowden Crater, as may be judged from the facts just mentioned, is a typical and most instructive example of a lava cone of the variety having a crater at the top. This crater is circular, and not an irregular gulf, produced by the breaking and partial subsidence of a dome of lava, as in the case of the highest of the Diamond Craters. The precise manner in which the crater's rim was built up is not clear, but apparently it was formed by the radial overflow of lava in thin sheets. The central part is perhaps due to a drawing off of the molten rock which once occupied it, through tunnels in the surrounding lava. It is possible, in this and other similar instances, that a circular cinder rim was formed about the summit of the conduit from which the lava rose by the cooling and running together of splashes of liquid lava. Craters formed in this manner would furnish a connection between those composed of lapilli and scoria and true lava domes, like the highest of the Diamond Craters.

SUMMARY.

The various phases of volcanic eruptions illustrated by the Cinder Buttes and by the Jordan, Diamond, and Bowden craters are such as pertain in general to volcanoes which, for the most part, discharge highly liquid lava. At each of these volcanic centers it seems that the first eruptions were of the explosive type, and that the elevations produced by the accumulation of projectiles—whether solid, plastic, or liquid—first formed were, to a considerable extent, and in some instances completely, buried by the subsequent quiet effusion of vast quantities of liquid lava. Among the more interesting of the minor phenomena associated with them are the craters which were built of ejected angular fragments which were blown out from the cooled and rigid lava at the summits of the volcanic conduits, and similar structures formed of material which was ejected in various conditions ranging from extreme viscosity to liquidity, and which formed scoria, bombs, lava cakes, and splashes of lava which became confluent after falling. The elevations built by the accumulation of such projectiles range, as has been stated, from lapilli cones or craters, due to the piling up of solid angular fragments, through similar craters composed in part or perhaps wholly of clots of plastic lava, volcanic bombs, and lava cakes to driblet cones and "ovens." The range in angle of slope on the exterior of these structures is from the neighborhood of 30 deg. for the loose angular fragments to nearly vertical for the adhering clots; the range in slopes of the interior of the crater walls is about the same as for the exterior. When the driblet cones are roofed over, their inner slopes, both on the outside and within, pass beyond the vertical and approach the horizontal.

The lava flows also present a wide range in the resulting details, such as typical pahoehoe with corrugated surfaces, and even hollow folds due to the influence of an underflow beneath a plastic crust, and equally typical *aa*, due to the breaking of a rigid crust on account of the energetic flow of still liquid lava beneath it. The occurrence of lava gutters (Figs. 10 and 11) and the presence, in numerous instances, of prominent pressure ridges on the recent lava sheets are also instructive features. The thin margins of liquid lava streams and the conspicuously abrupt and rugged extremities of highly viscous lava flows are illustrated in Figs. 12 and 13.

All the material extruded from the volcanoes described above is basalt, and represents the more easily fusible of lavas.

In many ways these modern volcanoes serve to illustrate the nature of the far larger outpourings of molten rock which, on cooling, formed the Snake River Plains and the still vaster, but, in part at least, somewhat differently erupted Columbia River lava. In a general discussion of volcanoes the Cinder Buttes, etc., may be considered as representing volcanoes of the quiet type, or such as erupt without energetic explosions, but their periods of activity were in all cases, so far as can be judged, initiated by explosions sufficiently violent to blow out projectiles, which on falling formed conspicuous elevations. They may be considered, therefore, as furnishing a connecting link between volcanoes of the explosive and those of the quiet type. These intermediate examples indicate, as has long been recognized, that the classification of volcanoes under two types, viz., explosive and quiet, is largely for convenience and that no sharply defined boundary separates the two.

E. Beuttner has contributed very interesting and useful papers on the assay of hydrastis. In the former the chief point that he draws attention to is the liability of ethereal solutions of hydrastine to deposit the alkaloid on standing. It has often been observed that alkaloids that are but sparingly soluble in ether are sometimes taken up in considerable quantity at the moment of liberation and deposited on standing. This

is the case with hydrastine, especially if the rhizome or fluid extract is rich in alkaloid. In no case should the proportion of solvent (a mixture of ether and petroleum spirit) be less than ten times that of rhizome, nor should the ethereal solution be allowed to stand long. The following is Beuttner's method for assaying liquid extract of hydrastis: Evaporate 8 grammes to 3 grammes in a 200 cubic centimeter flask on the water bath, add 10 grammes of water, 70 of ether, 10 of petroleum spirit, and 5 of ammonia. Shake violently for three minutes, allow to separate, and pour off 60 grammes through a plug of wool into a separator. Transfer the alkaloid to dilute hydrochloric acid, add 60 grammes of ether and 5 cubic centimeters of ammonia, shake well for five minutes, pour off 50 grammes, dry, and weigh.—Schweiz. Woch.

CONTRIBUTIONS TO OUR KNOWLEDGE OF RADIUM.

By W. Marckwald.

I. ON THE SEPARATION OF RADIUM FROM BARIUM.

Hitherto only one method has been available for the separation of a mixture of salts, richer in radium, from the radium-barium salts as obtained from the uranium minerals. By the fractional crystallization of the chlorides (according to Curie) or, more advantageously, of the bromides (according to Giesel) it is possible to accumulate the radium salt to any desired extent in the more difficultly soluble fractions. This method of crystallization is very detailed, because of the isomorphism of the barium and radium salts (*cf.* W. Marckwald, Chemical News, 1901, lxxxiv., 190; Rinne, Centralbl. f. Min. u. Geol., 1903, 134-141).

The idea that it might be possible to separate the two alkali earths from one another by a suitable electrolytic method, induced me to arrange an experiment the result of which confirmed this conjecture. The concentrated aqueous solution of a quantity of radium-barium chloride* was allowed to stand, and shaken up frequently with about a fifth of its weight of sodium amalgam. Only a very slight decomposition of water takes place, but a very considerable part of the sodium goes into solution as ion, while an equivalent quantity of radium and barium amalgam is formed. The proportion of radium to barium in the amalgam is by no means the same as in the solution, but is very much higher. If the amalgam is separated from the solution after the action has lasted one to two hours, decomposed with hydrochloric acid, and a small quantity of chloride resulting on the evaporation of the hydrochloric acid solution is compared on the phosphorescence screen with an equal quantity of the salt remaining in the original solution, then it appears, without any necessity for applying a more delicate method of measuring, that the first salt far exceeds the latter in activity.

By repeating the operation many times, after first properly neutralizing the solution, we obtain from the amalgams fractions of salts, the activity of which gradually decreases.

In the above form, the new method of accumulating the radium offers no important practical advantages over the crystallization method, for in both cases the aim in view is only reached by a process of fractionation. Whether it is possible to simplify the process for obtaining radium from the raw product by further development of this method does not yet appear. Meanwhile, this observation which I now communicate is of interest, because for the first time a difference is exhibited in the behavior of radium and barium.

II. ON THE PHOSPHORESCENCE OF THE ANHYDROUS RADIUM-BARIUM CHLORIDE.

It is well known that mixtures of anhydrous radium and barium chloride, even when they contain very little active salt, are strongly phosphorescent, while the hydrous crystalline salts either do not phosphoresce at all or only very slightly. This phenomenon is to be ascribed to the fact that phosphorescence is excited in anhydrous barium chloride by the Becquerel rays, both by α and β-rays, and not in the hydrous crystalline salt. Thus, if a little rod coated with radio-tellurium, which only emits α-rays, is brought up to the first salt, it becomes brightly luminous, as well as at the approach of a radium preparation inclosed in an aluminium capsule, which gives out only β-rays. On the other hand, the crystalline hydrous barium chloride shows no phosphorescence under the same conditions.

III. ON INDUCED RADIO-ACTIVITY.

The interesting publication of F. v. Lerch (Ann. d. Phys., (4), xii., 745) on the induced thorium activity leads me to communicate some observations on the induction of the radio-activity of radium solutions on metals, although the research is not yet completed.

Freshly prepared solutions of radium salts, which had been kept in a dry state for a long time, and had thus reached their maximum activity, are, according to Curie's and Giesel's researches, strongly active, but the activity rapidly dies away—according to Rutherford because the emanation is given up—until it has reached a minimum. If in the solution of the radium-barium chloride mixture, as it is obtained directly from the Joachimsthal pitch-blende, metals are immersed after the solution has stood for many days, these are rendered only very slightly active by induction, but if freshly prepared solutions are used, after remaining a short time in the solution *certain* metals become very strongly active. This activity reaches its maximum in from 15 to 30 minutes, and slowly diminishes in the course of a day after removal from the solution. The induced metal emits both α and β-rays, which in the case of some metals are strong enough to enable the phosphorescence of the zinc blende screen by direct radiation (α-radiation), as well as that of the barium platinum cyanide screen, through a layer of cardboard (β radiation) to be seen even in an imperfectly darkened room. A noteworthy difference is shown between the different metals as regards the intensity of the induction. Under exactly the same conditions, the degree of induced activity appears to depend generally on the position the metals occupy when arranged in a series, according to their contact forces. At any rate the induction decreases in the metals magnesium, zinc, tin, copper, silver, bismuth, palladium, in this order, and the differences are so great that in observing the action on the phosphorescent screen, it is at the most only in the case of neighboring members of the series that there can be any doubt.

If many strips of the same metal are immersed in the same solution of the salt one after another at short intervals, i. e., after about one or two hours, generally no noticeable diminution of the inductive action is to be observed. An exception must be made only in the case of magnesium. While the first strip becomes very strongly active, all the subsequent ones are only slightly acted upon. The phenomenon must be ascribed to the fact that the solution, by the immersion of the first magnesium strip, becomes alkaline, if only to a very slight extent. This is inferred chiefly from the fact that magnesium is made very strongly active, and the action is continuous, if the solution is kept acid by the addition of a small quantity of hydrochloric acid.

It might be thought that in acid solution the surface of the metal is kept clean, while in neutral solution it is covered with a layer of oxide, and that this hinders induction. Hence a little ammonium chloride was added to the neutral solution of the radium salt; thus the magnesium oxide was dissolved, the solution becoming alkaline. In this case the strong inductive action was absent.

These observations led me to examine the behavior of zinc and copper in a solution of radium chloride made feebly alkaline by ammonia, and in another made feebly acid by hydrochloric acid. It then appeared that the zinc, which is chemically allied to magnesium, behaved in an exactly analogous manner, while the copper was about equally strongly acted upon in both solutions.

In conclusion, it must be mentioned that all these experiments were confined to the slightly active radium preparation mentioned above. Whether radium salts containing high percentages will give analogous phenomena has not yet been examined.—Berichte der Deutsch. Chem. Gesell.

* For this experiment a mixture of salts was used, which had been obtained from Joachimsthal pitch-blende without further increasing the proportion of radium.

THEORY OF RADIO-ACTIVE PHENOMENA.

In a paper recently read before the Prussian Academy of Sciences, R. Schenck proposed a theory of radio-active phenomena, which is based on the hypothesis that electrons in phenomena of chemical equilibrium and more particularly in the one between oxygen and ozone, are controlled by the law of mass effects (law of Guldberg and Waage). In a previous paper prepared in conjunction with Prof. Richartz, Marburg, the author had shown ozone to belong to the group of radio-active substances, which is quite important, as this is a body available in any amount. He had pointed out that ozone, on being dissociated, will become a conductor of electricity, i. e., will be converted into oxygen, while giving off gaseous ions. On the other hand, its formation takes place whenever, in certain electric phenomena, gaseous ions are present. This is thus a reversible process, being perfectly analogous to the dissociation phenomena; and if gaseous ions be considered as material particles, ozone may be said to be formed from oxygen and gaseous ions, i. e., to be a chemical compound of electrons and oxygen, or else an "electronide" of oxygen. Both electrons and atomical ions would be controlled by the mass law in the same way as electrolytic ions and electrically neutral molecules. A difference between the dissociation of ozone and most processes of dissociation would be the evolution of heat attending this reaction, by means of which ozone should be considered as an endothermical compound. As, accordingly, the equilibrium constant of this reaction will decrease for increasing temperatures, the constancy of ozone must augment in proportion. The concentration of the gaseous ions given off from ozone will equally be smaller than with ordinary low temperatures.

Mr. Schenck allows for the well-known fact that strongly active radium compounds will give off a small quantity of ozone, by the ionization of air due to gaseous ions as given off from radium, in virtue of which ozone is produced from the surrounding oxygen. The hypothesis is suggested that radium and analogous substances would also be "electronides." The condition of equilibrium would, it is true, be in these cases somewhat different from those relative to gaseous ozone. The process would be analogous to the dissociation of calcium carbonate into calcium oxide and carbonic acid. The author thinks it probable that the radio-active substances should be produced by volcanic phenomena, attended by violent evolution of electricity. As in many slow reactions, giving rise to the formation of ozone, such as the oxidation of organic substances, for example, the presence of gaseous ions has lately been ascertained, it is probable that many, if not all, chemical reactions are attended by the presence of such gaseous ions in variable quantities. As, on the other hand, hydrogen peroxide, as frequently produced with processes of self-oxidation, is perfectly analogous to ozone, giving off, as is well known, so-called emanations which influence photographic plates through a sheet of aluminium, it should equally be considered as an electronide.

Guldberg and Waage's law accounts for certain remarkable phenomena, such as, for instance, the fact that phosphorus, while being non-luminous and inoxidizable in pure oxygen under atmospheric pressure, will become luminous and undergo an oxidation as soon as the concentration of oxygen becomes less. The maximum luminosity pressure of phosphorus will depend on the temperature increasing as soon as small amounts of ozone are added to the oxygen. In order to produce a luminous sensation on our eye, the concentration of the ions apparently should exceed a certain limit. After enunciating the hypothesis that the "emanations" of radio-active substances are nothing else than ozone, the author tries to account for the excited radio-activity by the action of ozone, to which would equally be due the phenomenon of spontaneous dispersion of electricity, as observed in dwellings and caves (where putrefaction and decomposition processes are most intense) with a much higher intensity than, for instance, in certain mines. A. G.

LORD KELVIN ON WAVES.

At a meeting of the Royal Society of Edinburgh Lord Kelvin, the president, read a communication "On Deep Water Two-Dimensional Waves Produced by Any Given Initiating Disturbance."

Lord Kelvin said his present communication was a continuation of a communication to the Royal Society of January 7, 1887, under the title "On the Front and Rear of a Free Procession of Waves in Deep Water." In that paper he had given a certain solution of the problem of finding motion of water under the influence of gravity undisturbed by wind, without any given initiatory disturbance. The special object of that paper was to find the beginning of such a disturbance and how it traveled into water previously undisturbed. An interesting question was raised and a solution given, but it was given in symbols, with an indication that tables would be prepared by which what was expressed in those symbols could be calculated, and the result explained and made palpable. He was sorry to say that that object, which was more difficult than the subject of the present communication, still remained undeveloped, although a complete solution of it was given in his former paper. He had said seventeen years ago that he hoped to return to the subject. He had the same hope still, and hoped that the future occasion would be at a much shorter interval than the interval from 1887 till now. The problem of the surface-action of waves in water was practically the same, however deep the water, but this problem of waves circling out in all directions from any disturbance of the surface of the water developed by throwing something overboard from a ship, for example, was a far greater problem. The thing that people knew best was the last thing to be solved by mathematics and nothing that could be done mathematically hitherto would allow a mathematician to calculate the waves circling out from anything thrown into the water. The mathematical view of anything of the kind was that, given the velocity with which the stone struck the water, they ought to be able to calculate the waves. They might not be able to do it, but they ought not to be satisfied unless they were able to make the calculation. But mathematicians could not do that unless they had the formula at their command. Having described the mathematical expression "two-dimensional" to mean a succession of straight crests approaching without lateral motion at any part and breaking on a straight line beach, Lord Kelvin gave the formula for arriving at a solution of the problem, and laid on the table the full calculated numbers, the whole showing the genesis of waves from a condition in which there was nothing undulating whatever. But, after all, he said, these were the result of a very elementary analysis, because they contained nothing but plain algebra and explanations.

HOW THE N-RAYS MAY BE OBTAINED.

There can be no doubt that the results obtained by M. Blondlot and others at Nancy are most remarkable, even if they should prove to be, as Herr Lummer's communication to the Berlin Physical Society would lead us to suppose, purely subjective, or, as he prefers to put it, "objective phenomena in the retina."

I have endeavored to repeat M. Blondlot's experiments, but quite without effect, using calcium sulphide screens of the dimensions he suggests, that is, about 16 millimeters by 2 millimeters.

A thin layer of gum is spread over a sheet of cardboard and the powder sprinkled over the surface until as large an amount as possible adheres to the screen. No difference in the color or intensity of the phosphorescent glow appears to take place when a lead screen or the hand is interposed between the phosphorescent screen and an Auer burner completely inclosed in a tin-iron box with an aluminium window, nor does the interposition of a quartz lens in various places have any effect.

A very much larger screen was exposed to the Auer burner, one half being screened with lead and the other with thin aluminium, so that only the latter half was exposed to the radiation of the N-rays. The luminosity of the screen was, however, quite uniform throughout, although a sharp line ought to have separated the two parts of the screen, as the intensity of

the phosphorescence should have been different in the two sides.

I am at a loss to find any other explanation of M. Blondlot's results than that he has come across a radiation to which some men are blind and others not so.

Self-hypnotism due to fatigue of the optic nerve may account for results of one observer alone if he were to manipulate the lead screens and to make observations at the same time, but I think that M. Blondlot will have taken the precaution to get others to work the screens for him while he observed, and then compared results.

I may perhaps venture to note that a few years ago, in the course of some photometric work with fluorescent bodies, I was led to try whether one fluorescent body would increase or diminish the brightness of another (Phil. Trans., vol. cxci., p. 92), but could not detect any such change within the errors of observation.

The fact that M. Blondlot has actually measured the wave-length of the N-rays leaves little doubt (in my mind) that what he observed is, in the true sense, an objective and not a subjective effect, but at the same time the fact also that so many others who have tried in apparently the same way have failed, and failed deplorably, leaves still less doubt that the precise conditions upon which the effect depends yet remain to be discovered.—John Butler Burke, in Nature.

[Concluded from Supplement No. 1476, page 23650.]

RADIUM.—III.

Induced Radio-Activity and the Emanation of Radium.—All bodies, solid, liquid, or gaseous, placed for some little time in the vicinity of a radium salt, acquire the radiant properties of the latter, become radio-active, and emit Becquerel rays. There is, in a manner, a transmission of activity from the radium salt to the bodies put in its presence. This constitutes the phenomenon of "induced radio-activity."

Induced radio-activity is gradually diffused through gases by induction. Moreover, gases themselves, in the vicinity of the salts of radium, become radio-active. The phenomenon occurs in a particularly energetic manner when the bodies to be rendered active are placed in a closed receptacle with a solid salt of radium, or, better, with a solution of a salt thereof. Moreover, Mr. Rutherford has shown that the activity taken on by such bodies is much greater when they

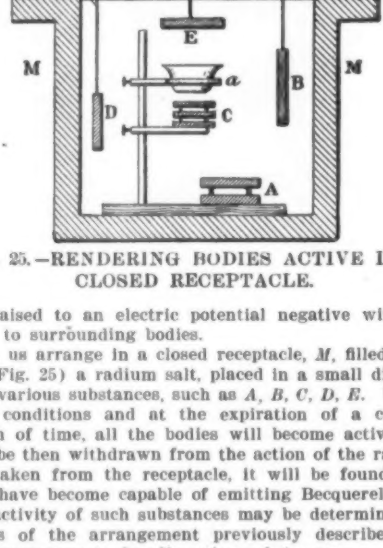


Fig. 25.—RENDERING BODIES ACTIVE IN A CLOSED RECEPTACLE.

are raised to an electric potential negative with respect to surrounding bodies.

Let us arrange in a closed receptacle, *M*, filled with air (Fig. 25) a radium salt, placed in a small dish, *a*, near various substances, such as *A*, *B*, *C*, *D*, *E*. Under such conditions and at the expiration of a certain length of time, all the bodies will become active. If they be then withdrawn from the action of the radium and taken from the receptacle, it will be found that they have become capable of emitting Becquerel rays. The activity of such substances may be determined by means of the arrangement previously described for the measurement of radio-active substances.

The activity acquired by the bodies, *B*, *C*, *D*, *E*, is the same whatever be their nature (lead, copper, glass, ebonite, cardboard, paraffine, or celluloid). Nevertheless, the activity of one face of one of the plates is higher in proportion as the free space opposite said face is greater. Thus, the interior face of one of the plates *A*, is less active than its exterior face. Bodies which have become active and which are removed to a distance from the radium salts preserve their activity for a certain length of time, after which it gradually diminishes and finally disappears.

It is found that the activity of the plate increases at the outset with the length of time that it remains in the receptacle, but that it reaches a certain limit-value after it has been there a certain length of time.

The nature and the pressure of the gas in the receptacle, and the relative position of the substances to be made active, have no influence upon the phenomena observed; and the activity acquired by the different bodies is proportional to the quantity of radium salt in the receptacle. The radiation of the radium salt plays no part in the production of the induced radio-activity. It is possible, in fact, to begin again the preceding experiment after having inclosed the radium salt in a sealed bulb. After several days, the electroscope will show that none of the plates placed in the receptacle emits Becquerel rays, since they have not become active. In order that the bodies may acquire the properties of emitting Becquerel rays, they must be connected with the radium salt either directly or through the intermedium of a gaseous substance.

The Emanation of Radium.—In order to explain such phenomena, we may suppose with Mr. Rutherford that the radium continuously disengages a radio-active material called "emanation." This emanation becomes distributed through space, becomes mixed with the gases that surround the radium salt, and is capable of acting in a peculiar manner upon the surface of solid bodies, so that it makes them become radio-active. The phenomena of induced radio-activity would therefore be the result of the transference of radio-active energy effected by the emanation.

All gases placed in the vicinity of radium salts become radio-active, and, according to the hypothesis

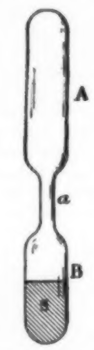


Fig. 26.—COLLECTION OF EMANATION IN A TUBE.

that precedes, are charged with emanation. Such gases may therefore communicate activity to the solid bodies placed in their presence. If an active gas be transferred to another receptacle, it will preserve for quite a long time the property of making radio-active the solid bodies brought into contact with it. Under such circumstances, however, the emanation contained in the gas becomes spontaneously destroyed, and the gas loses its active properties. About half the emanation contained in a body of gas will be lost in four days.

The radium salts are the center of a constant discharge of emanation. If we inclose a solution of a radium salt in a bulb half full of liquid, the emanation will accumulate in the gas above the solution. This emanation does not increase indefinitely, but becomes partially dissipated, in fact, while the radium produces a new quantity of it. The limit-equilibrium is obtained when the loss resulting from the disappearance of the emanation counterbalances the continuous production of emanation of the radium salt.

Disappearance of Radio-Activity Induced by the Salts of Radium in a Closed Receptacle.—Let us suppose that we accumulate emanation in a tube, *A* (Fig. 26), in putting it in communication with a bulb, *B*, containing a radium salt—in solution. At the expiration of a few days, the air contained in the tube, *A*, will have become charged with emanation, have become radio-active, and have communicated activity to the walls. If we afterward separate the tube from the bulb, by closing the part, *a*, by means of a lamp, we shall find that the tube, *A*, emits Becquerel rays. For this purpose, we use an experimental arrangement analogous to the one employed for determining the intensity of the radiation of radio-active matter, but in which a cylindric condenser is substituted for the one with plates. This condenser (Fig. 27) consists essentially of two concentric tubes, one of which, *B*, of thin aluminium, is connected with a battery having a large number of cells, and the other, of copper, is connected with the electrometer and the quartz. This combination of tubes is placed in a metallic box, which is grounded. By means of this apparatus, it is possible to study the external radiation of the receptacle, *A*, by placing it within the interior cylinder of the condenser. The

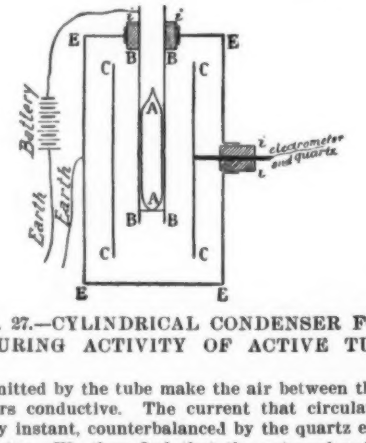


Fig. 27.—CYLINDRICAL CONDENSER FOR MEASURING ACTIVITY OF ACTIVE TUBES.

rays emitted by the tube make the air between the two cylinders conductive. The current that circulates is, at every instant, counterbalanced by the quartz electric piezometer. We then find that the external radiation of the tube, *A*, diminishes with the time according to a rigorous exponential law, which is as follows: $I = I_0 e^{-kt}$, where *Io* is the initial value, and *I* the value of the radiation at the instant *t*. Taking the second for unity, we have $k = 2.01 \times 10^{-6}$. The radiation decreases *one half in four days*. This law (Fig. 28) is absolutely invariable whatever be the conditions of the experiment (dimensions and nature of the reservoir, pressure and nature of the gas, intensity of the phenomenon at the outset, and the temperature). The constant of time that characterizes the disappearance of the activity of the tube is a characteristic datum utilized for rendering radium active. Such constant might serve for defining a constant of time.

This law is, in reality, that of the spontaneous disappearance of the emanation. In fact, if, after having made a tube such as *A* active, we form a vacuum therein, so as to extract the air charged with emanation, we shall find that the radiation diminishes much more rapidly, and, in fact, decreases one-half during each half hour. This law is the same as that according to which solid bodies made active lose their activity in the open air. We are therefore led to conclude that the activity of the receptacle, *A*, is kept up in part by the emanation that it contains, and that the law ascertained corresponds well to the distraction of the emanation.

Disappearance of the Radio-Activity Induced by Radium upon Solid Bodies.—A solid body made active and then withdrawn from the action of the emanation has its activity destroyed according to a law which is relatively complex at the outset; but, after two hours of such destruction, the activity of the body diminishes as a function of the time according to an exponential law, and becomes less by one-half during each period of half an hour. If the body has been submitted to the action of the emanation for more than twenty-four hours, the law of the destruction of activity is given by the difference of two exponentials.* The activity decreases by one-half in twenty-eight minutes. If the duration of activity has been less than twenty-four hours, the law becomes exceedingly complex, and the curves representing the phenomena assume quite varied forms. For a period of a few seconds, for example, we observe an abrupt decrease of activity, and then the radiation increases, passes through a maximum, and begins to diminish again, and, two hours afterward, the activity has resumed its normal value. It decreases one-half in twenty-eight minutes. In this case the interpretation of the phenomenon becomes quite a delicate matter, but presents, nevertheless, a great theoretical interest. We are led to suppose that, upon the

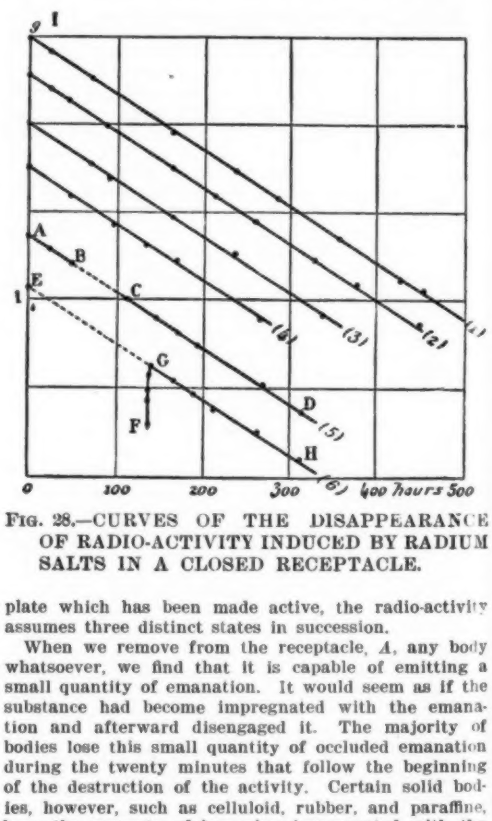


Fig. 28.—CURVES OF THE DISAPPEARANCE OF RADIO-ACTIVITY INDUCED BY RADIUM SALTS IN A CLOSED RECEPTACLE.

plate which has been made active, the radio-activity assumes three distinct states in succession.

When we remove from the receptacle, *A*, any body whatsoever, we find that it is capable of emitting a small quantity of emanation. It would seem as if the substance had become impregnated with the emanation and afterward disengaged it. The majority of bodies lose this small quantity of occluded emanation during the twenty minutes that follow the beginning of the destruction of the activity. Certain solid bodies, however, such as celluloid, rubber, and paraffine, have the property of becoming impregnated with the emanation, and of subsequently emitting it for several hours and even for several days. The law is completely modified. If the duration of their stay in the presence of the emanation has been greatly prolonged, the bodies, when withdrawn from its action, begin to lose their activity in the first place, according to the ordinary law (one-half in twenty-eight minutes), but the activity does not completely disappear. A residual activity several thousand times less than the activity at the outset still remains, and manifests itself for some years.

Induced Activity of Liquids.—Liquids, too, are capable of becoming radio-active. If we place a radium salt in a receptacle along with liquids such as water, saline solutions, or gasoline, we shall find that they become slightly active, and it would seem as if the emanation dissolved in them, since, if we inclose such liquids in a sealed bulb, the radiation emitted by the latter diminishes one-half in four days.

Radiation of Radium Salts in Solution.—If we put a solution of a radium salt into a tube and seal the latter, we may find, at the end of a short time, that when the tube is examined in the dark, the glass is luminous. The portion of the tube in contact with the gas is more highly luminous than that in contact with the solution, because the gas charged with emanation

* This law is then of the form $I = I_0 [a e^{-bt} - (a-1) e^{-ct}]$, where I_0 is the intensity at the moment at which the plate is withdrawn from the action of the emanation. The value of the coefficients is: $a = 4.2$; $b = 0.000413$; $c = 0.000538$.

acts strongly upon the side of the tube. The solution emits only a few rays, while the gas charged with emanation radiates strongly, as well as the tube. Under these conditions, it looks as if the radium salt behaved only as a producer of emanation; its properties have become modified and its radio-activity exteriorized. We may find, too, that the activity of the solution increases and does not reach a state of stability until a month after the closing of the bulb. This equilibrium becomes established when the spontaneous loss of activity becomes equal to the production of emanation.

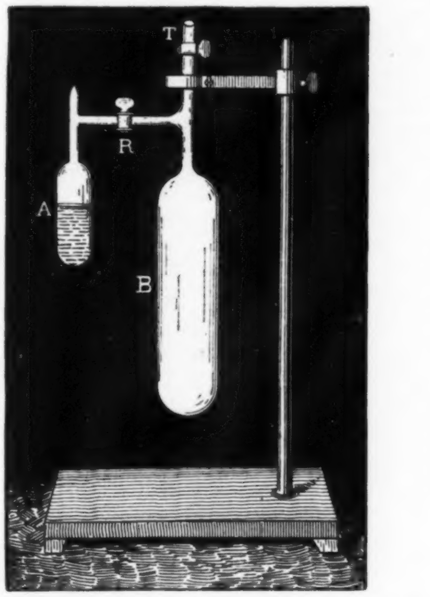


FIG. 29.—PHOSPHORESCENCE CAUSED BY THE EMANATION OF RADIUM.

The preceding considerations offer an explanation of the variation in activity of the salts of radium when they are heated or dissolved. We may, in fact, conclude that the emanation produced by radium can escape from the solid salt only with great difficulty, and that it accumulates in the salt and becomes transferred into induced radio-activity. The effect of heating is to cause a disengagement of emanation. The salt, brought back to the initial temperature, emits fewer rays by far. It gradually resumes its activity owing to the continuous emanation that it produces and that accumulates in the salt itself in the form of radio-activity.

The effect of dissolving is analogous. It produces a state of division of the material such that the emanation can easily escape. If the solution be evaporated, the dry salt will at first possess but slight activity, but will gradually resume its initial activity through a mechanism identical with the preceding.

PROPERTIES OF THE EMANATION.—*Effect of Phosphorescences.*—The emanation of radium causes an intense phosphorescence of a large number of bodies. Glass reservoirs containing air charged with emanation become luminous, Thuringia glass being the most sensitive. Sidot's sulphide of zinc becomes particularly brilliant under the action of the emanation and gives a very intense light. The experiment can be performed, for example, by means of an apparatus consisting of a large glass reservoir half of which is coated with sulphide of zinc (Fig. 29). A vacuum is formed in this reservoir through the tube, *T*, and air charged with emanation is afterward let in from a reservoir, *A*. The tube, *A*, contains a solution of a radium salt, and the emanation disengaged has accumulated in the gaseous part. As soon as the cock, *R*, is opened, the reservoir, *B*, becomes very luminous, and the light emitted by the sulphide of zinc is sufficiently bright to permit of reading being done at a distance of 4 or 8 inches from the tube.

Diffusion of the Emanation.—The radium salts disengage emanation continuously. This emanation gradually spreads to the center of the gas that surrounds the radium salt, becomes diffused in gas, and is capable of spreading from one reservoir to another, even through a capillary tube.

A study of the diffusion of emanation by capillary tubes has made it possible to determine the value of the coefficient of diffusion. The method employed is very simple, and consists in measuring, as a foundation of time, the Becquerel radiation emitted by a glass reservoir filled with air which has been made active. This reservoir communicates with the atmosphere through a capillary tube. The measurement of the radiation of the tube is effected by means of the apparatus described above (Fig. 27). From the measurement of the radiation is deduced the law of the flow of the emanation. It is found that the velocity with which the emanation flows is proportional to the quantity of emanation that exists in the reservoir, and that it varies proportionally to the section of the capillary tube and in inverse ratio to its length. The coefficient of diffusion of the emanation in air is equal to 0.100 at a temperature of 10 deg. C. (50 deg. F.), and is therefore nearly the same as that of carbonic acid in air, which is equal to 0.15.

The Emanation of Radium, and Gay-Lussac's Law.—The emanation of radium follows Gay-Lussac's law, for it expands the same as gas. An experiment to demonstrate this may be performed as follows: Two reservoirs, *A* and *B* (Fig. 30), filled with emanation, communicate through a tube, *t*. The radiation of one of the tubes, *A* (the other, *B*, being kept at the surrounding temperature) is measured in a cylindrical condenser. If the reservoir, *B*, be raised to a higher temperature, *T*, the radiation of *A* will increase and continue as long as *B* is kept at the temperature, *T*. The quantity of emanation that has entered the reservoir, *B*, is exactly the same as that which we should calculate by applying the Gay-Lussac law. The emanation has therefore expanded.

Condensation of the Emanation.—Messrs. Rutherford and Soddy have shown that the emanation of radium condenses in liquid air. A current of air charged with emanation loses its radio-active properties when passed through a worm immersed in liquid air. If the worm be raised to the temperature that prevails in the surrounding air, the emanation will return to its prior state. The vaporization of the emanation takes place at about —150 deg. C. The temperature of condensation of the emanation is therefore —150 deg. C.

This phenomenon may be very strikingly demonstrated by means of the apparatus shown in Fig. 31. A solution of a radium salt is placed at *A* in a glass reservoir communicating, through tubes, *t* and *t'*, and cocks, *R* and *R'*, with two reservoirs, *B* and *C*, coated internally with phosphorescent sulphide of zinc and in which a vacuum has been previously formed. If the apparatus be placed in the dark, the tube, *A*, alone will be slightly luminous; but if the cock, *R*, be opened, the emanation accumulated in *A* will be sucked into and diffused through the reservoir, *B*, causing an intense phosphorescence of the sulphide of zinc contained therein. If, now, the cock, *R'*, be opened, the reservoir, *C*, will become illuminated in its turn. At the same time, we shall observe a diminution in the luminosity of *B*. The emanation is divided in the ratio of the volume of *B* to the sum of the volumes of *B* and *C*. Finally, if the reservoir, *C*, be immersed in liquid air, it will increase in luminosity, while the brilliancy of *B* will disappear. The emanation, in fact, will gradually flow from the reservoir, *B*, and condense in *C*, in the liquid air. The cock, *R'*, may then be closed, and the apparatus be removed from the liquid air. All the emanation will have accumulated in the cooled portion, and the reservoir, *C*, alone will be luminous, and very intensely so.

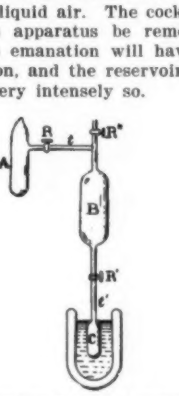


FIG. 31.—CONDENSATION OF EMANATION IN LIQUID AIR.

Distillation of Induced Radio-activity.—A plate of platinum made active and then heated, loses the greater part of its activity. If, during the heating, we surround the plate with another one kept cold, we shall find that the latter becomes radio-active, there occurring a transfer of radio-activity. The phenomenon is somewhat complex. The laws of the destruction of activity in the plates thus made active depend upon the temperature at which the distillation is effected. In this phenomenon we may conclude that it is the activity that distills from the plate made active. The induced radio-activity of solid bodies may perhaps be due only to an emanation condensed upon them. The

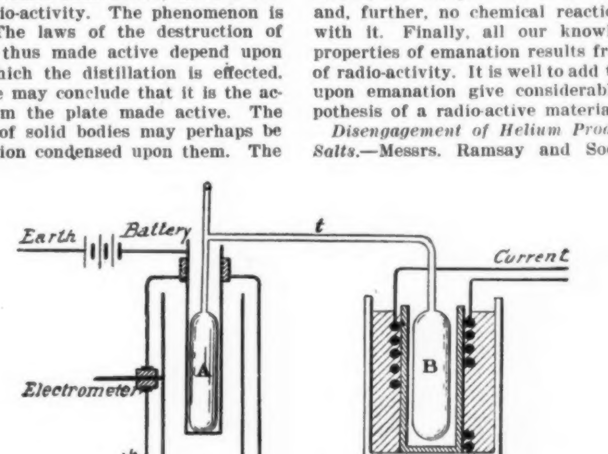


FIG. 30.—VERIFICATION OF GAY-LUSSAC'S LAW FOR EMANATION.

general results obtained permit of supposing that the radio-activity acquired by solid bodies assumes these successive and distinct states. The action of the temperature permits of distinguishing them.

Radio-Activity Induced upon Substances That Have Remained in Solution with Radium Salts.—When we leave a dissolved salt in contact with a solution of a radium salt for some time, the salt will acquire a certain activity, and, if it be separated from the radium, will possess an induced activity. We may, for example, make a barium salt active by this method, and the salt will retain its activity after it has undergone various chemical transformations. Its activity is therefore a somewhat stable atomic property. Chloride of barium made active becomes divided up like radiferous barium chloride, the most active parts being the least soluble in water and dilute hydrochloric acid. The dry chloride is spontaneously luminous, and its Becquerel radiation is analogous to that of radiferous chloride of barium. The activity of such a product may become a thousand times greater than that of uranium. None of the rays of radium, however, can be detected in the spectrum. Moreover, the activity of the product diminishes, and, at the end of three weeks, is three times weaker than it was at the outset.

Induced Activity Produced by Agents Other than Radio-active Substances.—It is of interest to note that various experiments have been made with a view to the production of induced radio-activity in substances other than radio-active ones. M. Villard submitted a bit of bismuth placed in a Crookes tube to the action of cathodic rays, and thus made it active, although but very slightly so, since it took eight days of exposure to obtain a photographic impression. Mr. MacLennan has prepared salts capable of discharging positively charged bodies.

Studies of this kind present a great interest. If, by using known physical agents, it were possible to create a noticeable radio-activity, in bodies primitively inactive, we might hope to ascertain the cause of the spontaneous radio-activity of certain matters in this way.

Presence of the Emanation in the Air and in Mineral Spring Water.—Messrs. Elster and Geitel have shown that atmospheric air always conducts electricity in a perceptible manner, that it is always slightly ionized, and that the ionization seems to be due to numerous causes. According to the researches of the above-named scientists, such air contains, in a very small proportion, an emanation analogous to that emitted by radio-active bodies. Upon mountain tops the atmosphere contains more emanation than it does on lowlands or at the seaside. Finally, the air of cellars and caverns is in particular charged with emanation. Air very rich in emanation is obtained likewise by sucking from a tube buried in the ground the air that it contains.

The presence of radium emanation has been detected in the gases extracted from certain natural mineral waters. It is possible that the curative physiological action of such waters is due to the radio-active principles that are contained therein. In therapeutics, there is here a question of very great importance.

The air derived from air or river water is nearly free from emanation.

Nature of Emanation.—Mr. Rutherford believes that the emanation of radium is due to a radio-active material gas of the argon family. The properties above described tend, in fact, to show that, from many viewpoints, radium emanation behaves like a true gas. When we put in communication two glass reservoirs, one of which contains emanation and the other none, the emanation becomes diffused through the second, and when an equilibrium is established, it is found that the emanation has divided itself between the two reservoirs in the ratio of the volumes. The emanation obeys the laws of Mariotte and Gay-Lussac. It diffuses itself in the air according to the law of the diffusion of gases, and, finally, it condenses at a low temperature like a liquefiable gas.

Certain points, however, are as yet very difficult of interpretation by such a hypothesis. Thus, up to the present, no one has observed any pressure due to emanation, nor the presence of a characteristic spectrum; and, further, no chemical reaction has been obtained with it. Finally, all our knowledge relative to the properties of emanation results from the measurements of radio-activity. It is well to add that recent researches upon emanation give considerable weight to the hypothesis of a radio-active material gas.

Disengagement of Helium Produced by the Radium Salts.—Messrs. Ramsay and Soddy ascertained the presence of helium in gases that had remained for a certain length of time in a sealed bulb containing a radium salt. The presence of helium exhibited itself constantly in various experiments, and the gas was recognized with certainty through its spectrum, which was obtained by means of a Geissler tube. The helium lines, moreover, were accompanied with three others that were unknown. The same scientists made another series of experiments, in which they accumulated the radium emanation by condensation in liquid air. They afterward studied the spectrum of the emanation by means of a Geissler tube, and again found the new

lines. As for helium, that was not present in the gas at the beginning of the experiments, but the spectrum of it gradually made its appearance and permanently increased in intensity. On the other hand, the new lines gradually disappeared. As a result of this, it is possible to suppose that helium is one of the products of the destruction of emanation. This production of helium is connected with the disappearance of the activity of gaseous mixture.

It is easy to understand the importance of this result, which might be interpreted by the theory that helium was created by the radium emanation. Were such the case, we should find ourselves face to face with a case of transmutation of simple bodies, that of radium into helium. Such a result, although very surprising, would nevertheless be in accordance with the fact that helium is found solely in minerals containing uranium and radium, and becomes disengaged therefrom when they are heated.

Some experiments now making tend fully to confirm these results, which are of fundamental importance.

Nature of the Phenomena Produced by Radium Salts.—From the outset of their researches upon radioactivity, M. and Mme. Curie have asked themselves whether radio-activity is not a general property of matter. Just at present, it is impossible to grant that this question has been solved. Mme. Curie has examined a very large number of substances and demonstrated that they do not possess an activity greater than a hundredth part of that of uranium. M. Colson, however, has shown that many substances are, in the long run, capable of acting upon photographic plates, and some recent researches tend to confirm that fact.

The examination that we have just made of the properties of radium salts shows that the latter, or, more generally speaking, all radio-active bodies, constitute sources of energy that reveal themselves to us in the form of Becquerel radiation, or continuous production of emanation, of electric, chemical and luminous energy, and of continuous disengagement of heat.

On the other hand, radium appears always to preserve the same properties, and not to become modified. These facts do not seem to agree with the fundamental principles of energy.

Since we still have great confidence in the principle of the conservation of energy, the first question that we must propose is whence such energy can come. It has often been asked whether energy is created in the radio-active bodies themselves, or whether it is borrowed by the latter from external sources. These two queries have been the starting-point of numerous hypotheses, of which we shall mention two that appear, just at present, to be the most satisfactory.

We may, for example, suppose that radium is an element in course of evolution, that its atoms are becoming transformed slowly, but continuously, and that the energy perceived by us is that which is brought into play in the transformation of the atoms. The fact that radium permanently disengages heat pleads in favor of such an hypothesis. This transformation, on the other hand, may be accompanied with a loss of weight due to the emission of material particles and a continuous disengagement of emanation. Up to the present, no variation in weight has been ascertained with certainty, but the fact that the radium salts disengage emanation that becomes converted into helium permits of supposing that the radium salts lose weight, and this gives considerable value to the hypothesis. Moreover, some experiments upon the variation of weight, based upon the determination of the weight of the helium produced, are now making.

The second hypothesis consists in supposing that in space, there exist radiations that are as yet unknown and are unappreciable by our senses. Radium may be capable of absorbing the energy of such hypothetical rays and of converting them into radio-active energy.

These two hypotheses are perhaps not incompatible. At all events, there are many reasons to be offered in favor of or against each, but, in most cases, the experiments made to verify the consequences thereof have given negative results.

This brief recital of the properties of radium salts may serve to give some idea of the importance of the scientific movement that has been called forth by the remarkable discovery made by M. and Mme. Curie, who have caused science to take a considerable stride. Aside from their great theoretical interest, the phenomena produced by radio-active bodies give physicists, chemists, and medical men some new means of investigation.

As abstract as they may be, *a priori*, the researches of pure science lead to utilitarian results more quickly than might be supposed.—Translated for the Scientific American Supplement from the French of Jacques Danne, in Le Genie Civil.

The United States Geological Survey, in a report on coal tar and ammonia production, said that comparatively little progress in the manufacture of chemical products from coal tar has been made in this country. Although we are producing over 50,000,000 gallons of coal tar annually, the principal uses made thereof are in the manufacture of roofing paper, the creosoting of lumber, and for the preparation of street-paving material, while at the same time we are importing millions of dollars' worth of chemicals obtained from coal tar as a raw material. The coal tar produced in this country in 1902 was worth at first hand $1,873,966. In the fiscal year ended June 30, 1902, the coal tar products imported into the United States were worth at point of shipment $7,494,340. The duty paid on these imports amounted to $1,594,799, making the total cost, exclusive of freight, other expenses, and jobbers' profits, $9,089,139. In the fiscal year ended June 30, 1903, the value of these imports was $7,690,885, duty $1,692,445, total $9,383,330. A conservative estimate would place the total value of these products in the wholesale markets of this country at $12,000,000 in both 1902 and 1903.

The following figures show the value of the coal tar products imported into the United States in the fiscal year 1903: Salicylic acid, $190,012; alizarine and colors or dyes, natural and artificial, $660,464; aniline salts, $789,553; coal tar colors or dyes not specially provided for, $5,252,611; coal tar preparations, not colors or dyes, $544,176; coal tar products not medicinal and not dyes, known as benzol, toluol, etc., $425,019; total, $7,690,885.

TRADE NOTES AND RECIPES.

Utilization of the Debris of Platinum.—It is sufficient to dissolve the pieces in aqua regia, 3 parts of concentrated chlorhydric acid, and 1 part of concentrated nitric acid. The liquid in excess is evaporated, and the platinum chloride left to crystallize.—Science, Arts, Nature.

Process for Making Rice Paste.—This is very simple. Mix the rice flour with cold water, and boil it over a gentle fire until it thickens. This paste is quite white and becomes transparent on drying. It is very adherent and of great use for many purposes.—Science, Arts, Nature.

Coloring Fluid for Brass.—Caustic soda, 33 parts; water, 24 parts; hydrated carbonate of copper, 5.5 parts.

Dissolve the salt in water and dip the metal in the solution obtained. The intensity of the color will be proportional to the time of immersion. After removing the object from the liquid, rinse with water and dry in saw-dust.—Science, Arts, Nature.

Destruction of Plant Lice.—The following process is employed at the National School of Horticulture at Versailles. The portion of the plant attacked is sprinkled with the following insecticide: Rich tobacco juice, one liter; black soap, one to two kilogrammes; carbonate of soda, one kilogramme; lamp alcohol, one liter; water, 100 liters. Dissolve the soap in the alcohol, and the crystals of soda in water. The liquid is applied with a sprayer. A single application is not sufficient. The treatment should be renewed several times when the spots reappear.—Le Cosmos.

Bronzing of Copper.—M. Manduit, a pharmacist at Caen, makes use of a formula for bronzing galvanic apparatus, which imparts any shade desired, from Barbedienne bronze to antique green, provided the liquid remains for some time in contact with the copper. After cleaning the pieces, a mixture made as follows is passed over them with a brush: Castor oil, 20 parts; alcohol, 80 parts; soft soap, 40 parts; water, 40 parts. The day after application, the piece has become bronzed; and if the time is prolonged, the tint will change. Thus, an affinity of shades agreeable to the eye can be procured. The piece is dried in hot sawdust and colorless varnish with large addition of alcohol is passed over it.—Le Cosmos.

A White Inactinic Light.—The method for obtaining a white inactinic light indicated by M. Liesing is as follows: A solution of three parts of nickel chloride (green) and one part of cobalt chloride (red) is colorless by transparency and becomes at a certain dilution as clear as water. As the light which passes through each liquid separately is inactinic, it must be so after passing through the mixture of the two solutions; and as such, does not act on the salts of silver. To absorb the ultra-violet rays, the vessel containing the solution of collodion mixed with sulphate of quinine, slightly acidulated with sulphuric acid, is kept covered. A sensitive paper exposed for a week to this light does not undergo any change.—Le Cosmos.

Liquid Gilding for Steel.—Gold leaf, chlorhydric acid, nitric acid, sulphuric ether.

Mix the two acids in the proportion of one part of nitric acid and three parts of chlorhydric acid; dissolve the gold leaf in it and evaporate till dry. The residue is to be dissolved in the smallest quantity of water possible. Then a volume of ether equal to three times the quantity of water is to be added. The liquor is to be shaken in a closely stoppered bottle until the layer of ether is colored yellow, and the water has lost all its color.

To employ this solution, immerse in it the steel object, previously polished. The surface will be immediately gilded. An imitation of damaskeen work may be obtained. It is sufficient to apply a varnish of wax to the parts before they are covered by the gilding.—Science, Arts, Nature.

To Harden Plaster Casts.—The following is one way of treating them: First dry the cast in an oven heated to about the temperature used for baking bread. When the cast has cooled down so that it may be handled without burning the hands, immerse it in a strong aqueous solution of alum, and leave it there until crystals begin to form on the surface, then remove and wipe dry. Any adherent crystals may be removed with a wet rag. Now return the cast to the oven, and heat, at a temperature of about 140 deg. F., until thoroughly dry. Remove and immerse in a bath of boiled linseed oil, cut with a little oil of turpentine. Let remain a few minutes, then remove, let the surplus oil drain back into the bath, and stand aside in a warm place to let the oil become "tacky," then apply bronze powder.—National Druggist.

ELECTRICAL NOTES.

J. Joly has discovered that a light disk, delicately suspended, and coated upon the one side with a few milligrammes of radium bromide of high activity, exhibits, when an electrified body is brought near it, motions very different from what would be observed in the case of an inactive substance. The electrified body, whether positive or negative in sign, repels the suspended body if brought up to it on the side coated with radium, but attracts it if presented on the naked side. Two explanations are possible. The effects may be ascribed to the presence of electrified particles or ions of both signs in the region between the radium and the fixed electrified body. Then if a plus charge is presented opposite the radium the positive particles are repelled against the vane, while the negative particles are withdrawn. The repulsion, since it hits the vane itself, will be the only effective force. The same thing, but with signs reversed, will take place if a minus charge is presented to the disk. Another explanation is that the presence of the charged body induces a charge of opposite sign upon the radium, and repels the charge of the like sign to the remote side of the disk. The first (attractive) charge rapidly dissipates owing to the ionizing influence of the α-rays, and the second (repellent) charge alone remains to exert a mechanical effect upon the vane. The author decided between the two theories by having two vanes connected with a wire and suspended in a Coulomb balance. He then obtained an attraction instead of a repulsion. The repulsion was restored on breaking the metallic connection between the vanes. This shows that the second explanation is correct. For when the repelled charge can escape into the other vane, its repelling action disappears.—Phil. Mag.

In a recent communication to the French Academy of Sciences, Mr. de Valbreuze records some experiments on mercury arcs in U-tubes, connected to a Sprengel air pump, when the following phenomenon would be observed for pressures in the cold tube ranging between 0.004 and 0.002 mm. of mercury: On the arc being first started, the anode would constitute a more or less great uniformly luminous surface, which later on becomes covered with small stars of a high brilliancy, forming regular geometric figures. These stars would frequently be located in the angles and the center of a perfectly regular pentagon or hexagon, or else they would be present in a great number, being of very small dimensions and very movable, regularly distributed on concentric circumferences. These different aspects would, as a rule, alternate with one another, appearing and disappearing with an extreme rapidity. As the electrode becomes hot, the stars will augment in size, assuming the form of spheric luminous pearls, placed on the mercury; afterward they would form groups, clinging to one another so as to form a luminous central disk and one or more concentric luminous rings being separated by dark rings. Finally, the dark rings would disappear, the anode resuming its usual aspect, namely, that of a uniformly luminous surface. In order to account for this phenomenon, the author suggests the hypothesis of a kind of surface membrane at the surface of the mercury, this membrane being more or less permeable to the current, and determining by its vibratory state the regular shape of the figures observed. In the second part of his communication, the author deals with some peculiarities in the starting of mercury arcs. According to current views, vacuum tubes with one or two mercury electrodes will require, in order to be started, a potential difference of some thousands of volts, when the normal passage of the current will take place with a fall of potential of only about 15 volts. Now, when applying to these tubes a potential difference of 550 volts, phenomena of spontaneous starting are observed under the following conditions: The anode tube being of iron and the cathode of mercury, a beautiful violet light is observed above the cathode, occupying the whole of the cross-section of the tube, as the internal pressure is about 0.015 mm. of mercury, a slight greenish luminescence surrounding the anode, whereas the remainder is dark. The current traversing the tube is found to be from 0.01 to 0.02 ampere. In nearly all cases, the normal arc is found to pass spontaneously after some minutes. If, on the other hand, the pressure be inferior to 0.015 mm., dropping as far as 0.006 mm., the preliminary phenomenon, while being quite identical, will be observed only in the case of the tube being somewhat hot, when the cathode light is found to diminish in intensity and to take a white color; the arc is seldom completed spontaneously, whereas by imparting to the tube a slight shock, it is produced instantaneously. In the case of both the anode and cathode being of mercury, the phenomena of spontaneous starting are much less frequent than in the former case, taking place only if the electrode be previously heated by the passage of the current and for pressures ranging between 0.006 and 0.015 mm., i. e., for the maximum of conductivity of the vacuum tubes. The phenomenon is attended by the appearance of a violet spot at the cathode and a greenish spot at the anode. The light will frequently fill part of the tube, forming stratifications, the color of which is violet on one side and greenish on the other, a dark room separating both layers. The spontaneous starting of the arc is rarely observed, while any shock will be sufficient to complete the same. As by stirring the mercury surface the difficulties met with in starting the arc are found to be materially decreased, the author thinks that a surface membrane, opposing especially in the cold state a high resistance to the passage of the current, plays a part also in connection with these phenomena.—A. G.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

How to Build up American Trade in Germany.—I am quite sure that the faulty methods employed by most of our manufacturers to secure and maintain trade in the Frankfort district apply to the whole of Germany.

It may be stated as a general truth that any article of manufacture which finds a ready sale in the United States will sell in Germany, provided it is placed before the public in a proper way and at a reasonable price. American goods are usually looked upon with favor by the general public here, although rival German manufacturers often try to disparage them. While the new German tariff, soon to come into force, will raise duties all along the line, still I believe that many American manufactures will be able to compete here with German goods and those of other countries in the German market. I do not believe, however, that sporadic efforts to introduce American goods will meet with success.

It will not do for an American manufacturer to expect a paying and lasting trade here unless he first carefully looks the field over. No man who is not an expert in the particular line of goods for which a market is sought here is qualified to give an opinion thereon that would warrant the American manufacturer in embarking in an export trade to Germany.

If an American manufacturer comes to the conclusion that he is so situated that he at all times will be able to promptly supply the German market with his goods, and believes that on account of the superiority of his manufacturing facilities he can compete with German and other products in Germany, he should, before doing anything else, either come here himself or send a reliable expert to study the situation on the spot, look into the rates of transportation and of duties, find suitable houses to act as his agents, etc. The comparatively small expense of such a course will cut no figure if he succeeds—even less if he sees that the business promises no profit.

My advice to every prospective American exporter to Germany (for that matter, to any other country) is first to acquaint himself with all the conditions of the market, carefully look up suitable agents, have the necessary contracts drawn up by reliable German attorneys in conformity with German laws, and make preparations, if it is decided to engage in the business, to be able at the shortest notice to supply what is needed by the German customers. I have frequently heard complaints by German firms handling American goods that their patience and that of their German customers has been sorely tried by the dilatoriness of American firms in shipping further supplies. Not infrequently German customers, becoming disgusted, gave up dealing in American goods solely for this reason and handled afterward only such German or other goods as could be supplied on short notice, although perhaps affording less profit.

There are many articles of American manufacture which would command a ready and profitable sale if the precautions I have tried to indicate be taken. The success of many American firms in doing business in Germany is well known. The statistics of our exports to Germany speak louder than individuals.

American Furniture.—One branch which, above many others, would seem to promise well is that of furniture for the poorer and middle classes. No country, on account of the abundant supply of raw material and of the large scale of manufacture and superiority of machinery, can compete herein successfully with the United States. If a furniture syndicate would send an intelligent expert over here to study the styles "in vogue;" establish depots, say, at Bremen, Hamburg, or some other suitable place; ship the furniture so as to get the benefit of the lowest rates (as ocean freights are based upon space, not on weight); furniture in "knock-down" shape, to be put together and varnished on this side, I feel certain an excellent paying business could be established provided the same were conducted by men well posted and possessing that commercial tact and intelligence which marks our successful business men at home.

A company with sufficient means would do a business here that would in all probability exceed their most sanguine expectations. I have no statistics at hand, but I believe that of all furniture imported into Germany the United States does not supply more than about 15 per cent. It should be 80 per cent. at least, and besides American furniture, for the reasons stated, should also supplant a great part of the German manufacture, as any expert coming over here would see at a glance.

American Boots and Shoes.—A very useful lesson of how to increase sales of American manufactured products in Germany is taught by the success attained by Mr. Adolf Barthman, of Newark, N. J., in American boots and shoes. For many years United States consuls in Germany had been pointing out the great possibilities for American footwear in Germany, but no American firm, to my knowledge, made other than sporadic efforts to gain this trade. In April, 1901, however, Mr. Barthman, assisted by his two sons, opened a store in Berlin for the exclusive sale of American shoes; a second store was opened in Frankfort February 27, 1902, and a third at Hamburg October 15, 1902. All these stores are doing a large business and have already given much uneasiness to German manufacturers.

The Chamber of Commerce of Leipzig, in its annual report for 1902 states:

"The boot and shoe industry could not look upon the past year with satisfaction. While prices for a large part of the required material, especially leather, were increasing, the manufacturers of boots and shoes could not effect an even approximately comparative increase in price for their manufactures. The cause was to be found in the decreasing demand as coexistent with the general economic depression; also in the complete cessation of exports and the glutting of the home market with foreign manufactures, especially of American origin. It was especially the highly developed American shoe industry which in late years has made considerable efforts to gain a firm foothold in the German market. It is a matter of rejoicing that at last the German dealers showed themselves opposed to the introduction of American shoes. This, however, did not deter American capital from continuing the competitive battle by establishing its own shoe sale rooms on the largest scale at Berlin, Hamburg, Frankfort, etc.

"Whether Leipzig will escape will depend upon the purchasing public, which so far has always shown especial preference for foreign products, although it knows it will be better and as cheaply served with home articles."

Other chambers of commerce have expressed themselves similarly. The statements of the Leipzig Chamber of Commerce, however, are not borne out by the official statistics.

Germany in 1902 was neither glutted with foreign shoes nor did German shoe exports cease; the latter were even larger in 1902 than in 1901, while the imports were smaller.

The imports of American fine shoes into Germany for 1902 were 67.6 tons, out of total imports of 698.5 tons, or less than 10 per cent, and they were less than the German exports to little Holland or Denmark.

It is gratifying, however, to note that the imports of American shoes in 1903 show a large increase over 1900 and previous years—due to the intelligent efforts of Americans like Mr. Barthman.

For the first six months of 1903, as compared with the same periods of the two preceding years, the imports of fine shoes into Germany were as follows, according to official statistics:

	1903 Met. tons.	1902 Met. tons.	1901 Met. tons.
Total imports........	368.7	366.3	428
Imports from the United States......	52.2	37.5	37.8

Miscellaneous American Manufactures.—The same reasons which apply to the imports of furniture and boots and shoes into Germany apply to a number of other articles of American manufacture, as, for instance, tools of all kinds, stoves, clocks, watches, sashes, doors and blinds, locks, hinges, doorknobs, improved machinery, etc.—in fact, to very many articles which are produced in the United States on a scale of magnitude hardly known in Germany or in other European countries.

New German Tariff.—The new German customs tariff, which passed the Reichstag on December 25, 1902, after one of the fiercest parliamentary fights ever had in that body, has not gone into effect yet, as this requires an imperial order, with the consent of the Federal Council (Bundesrath), which has not been issued so far, nor have the rules and regulations with reference to the new tariff been established. This new tariff, as has been stated quite often heretofore in the press and in consular reports, has placed higher duties on many articles than the old one calls for. The country of origin must be clearly stated with reference to goods subject to differential duties in the invoices. In doubtful cases the customs authorities may call for further and more specific evidence.—Richard Guenther, Consul-General at Frankfort, Germany.

American Trade and Capital in Newfoundland.—Imports.—The imports into Newfoundland from the United Kingdom are positively declining, those from Canada have increased but very slightly, while those from the United States have increased nearly 50 per cent during the last three fiscal years, as will be seen by the following official figures:

Whence imported.	1901.	1902.	1903.
United Kingdom ...	$2,329,621	$2,208,505	$2,147,827
Dominion of Canada.	2,489,499	2,609,155	2,869,897
United States	2,088,465	2,500,066	2,920,914
All other countries..	568,917	508,659	541,306
Total	$7,476,502	$7,826,385	$8,479,944

American Investments.—American capitalists are among the foremost in developing the wealth of Newfoundland. Of such interests I may mention the York Harbor copper mine, the Benoit chrome mine, the Valley Island and the Bay Vert pyrite mines. The York Harbor deposits are the richest copper beds in the world, and the present owners are spending $250,000 in their development.

In the lumber industry the company headed by Mr. H. M. Whitney, of Boston, has acquired several large properties in the colony and is operating them on a hitherto unequaled scale. Mr. George J. Barker, of Boston, has also acquired a large grant and is developing it extensively. An American syndicate is now negotiating for forest tracts on the west coast for charcoal manufacture as well as for ordinary lumbering.

American Trade Outlook.—There is room for the sale of large quantities of American machinery for lumbering and pulp making. Harmsworth, the great London publisher, has secured a large forest area and is now arranging for the establishment of a pulp and paper making plant to cost $2,500,000. The United States practically controls the trade in agricultural machinery, but now, when American capitalists are interesting themselves to such a large extent in the development of the industries of Newfoundland, is a good time for an aggressive campaign by American manufacturers for the general enlargement of their trade in the colony.

Postal Rates.—The postal rate from the United States to Newfoundland is 5 cents per half ounce—not 2 cents, as to the Dominion of Canada (Newfoundland not being a part of the Dominion), a fact which many American correspondents, to their own loss, seem to forget. Through this oversight considerable business is lost, twice the shortage being charged, and letters are frequently refused by those to whom they are addressed.—George O. Cornelius, Consul at St. John's, Newfoundland.

Efforts to Promote Trade in China.—His Excellency Tsen, viceroy of the Two Kwangs, has issued a proclamation inviting the merchants of the 72 guilds of Canton to hold a meeting for the purpose of dealing with the promotion of trade in Canton. In connection therewith, he has offered the following suggestions for their consideration:

1. A chamber of commerce should be established, every guild to be represented by a leading merchant. Constant meetings should be held, so that all disputes between merchants can be settled and all complaints can reach the ears of the high authorities at once. Branches of the chamber of commerce should also be established in Chiu-Chow and Shiu-Hing to co-operate.

2. Inspectors of commerce should be employed to inspect all exports, imports, and native products, and all other things connected with trade.

3. There should be exhibitions of articles, native and foreign, to extend the knowledge of the chamber of commerce.

4. Men should be employed to report all the market quotations, the conditions of the market, and all other things connected with commercial business.

5. Commercial training schools should be opened.

6. The chamber should consult with merchants in foreign countries and ask them their advice as to the promotion of commerce.—R. M. McWade, Consul-General at Canton, China.

Wages in Italy.—Consul Pietro Cuneo, of Turin, Italy, under date of October 6, 1903, writes:

Seeing some men and boys carrying brick and stones in baskets on their shoulders, with no further protection than their shirts, up four stories to the masons and bricklayers, and noting how hard they worked, I asked a well-informed person how much they received per day and he gave me the following general trade figures as those prevailing in the city of Turin:

Laborers:	
Boys	$0.20 to $0.30
Men	.40 to .50
Bricklayers	.80 to 1.00
Stonecutters and carpenters	.60 to .70
Painters and frescoers..................	.40 to .50
Experts	.60 to .75
Laborers in the employ of the city......	.40 to .60

American Purchasers of Siberian Furs.—An American company is very liberal in offering high prices for furs of various kinds here. The prices recently offered were $5.41 for foxes and 23 cents for squirrels. At such prices the merchants will naturally stop the transportation of furs to Irbit and other places of fur trade. From the Transbaikal Province comes the news that sable hunting during the past winter has been a great success. The number of sable skins on hand is larger than in any of the preceding seasons. Buyers avail themselves of this abundance and offer the hunters very low prices. The average price paid to the hunters is from $12.88 to $15.45. The buyers expect to make 300 per cent profit on the purchased sables. The high price of furs for the past few years has attracted foreign merchants to this region. An American from New York came *via* Irkutsk early in the season and visited the whole maritime coast. He purchased chiefly sables, paying from $18.03 to $38.63 per piece, purchasing in all, it is said, $77,250 worth. He got ahead of the English and Russian buyers. The Russian merchants arrived on the first steamer, the "Soongari," but they could get only a small number at the auction. Even here the enterprising American outbid them. Squirrels were sold at 33 cents each.—Richard T. Greener, Commercial Agent, Vladivostock, Siberia.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SELECTED FORMULA.

Lavender Smelling Salt.—The following is a good formula:

Essential oil of lavender	18 parts.
Attar of rose	2 parts.
Ammonium carbonate	480 parts.

Mix.—Nat. Druggist.

Curry Powder.—Just what "Crosse & Blackwell's curry powder" contains, probably no one outside of that ancient corporation knows. Certainly we do not, but the following makes a curry that to our mind is quite as good:

Curcuma root	40 parts.
Cinnamon	25 parts.
Coriander	25 parts.
Black pepper	10 to 15 parts.
Pimento	20 parts.
Capsicum	5 to 10 parts.
Cardamom	5 to 10 parts.
Ginger	20 parts.
Nutmeg	5 parts.
Bread, dried or toasted and rubbed with garlic	25 parts.

Powder separately and mix thoroughly, sifting the powders together three or four times. If garlic be unpleasant it may be left out, though mixed in the manner indicated the ingredient conveys no hint of the usual garlic odor. The quantity of red pepper, or of black may also be altered at will.—Nat. Druggist.

Paste for Paper on Glass for Ornamental Purposes.—

1. Gum arabic, best selected	4 parts
Tragacanth, powdered	1 part
Glycerin	2 to 3 parts
Distilled water	32 parts

Dissolve the gum arabic in a part of the water, and the tragacanth in the remainder; mix the solutions and stir in the glycerin.

2. Gum arabic, best	1 part
Syrup, simple	5 parts
Rice starch	1 part
Boiling water sufficient.	

Dissolve the gum arabic in just enough water to dissolve it. Pour on the starch enough water to make a thick, pasty mass, then mix in the gum solution, and boil until the starch gelatinizes.

The following is very tenacious, and may be used wherever a paste is needed around the shop or laboratory:

Gelatin, best hard	2 parts
Arrowroot	10 parts
Alcohol	8 to 10 parts
Water sufficient to make	100 parts

With a portion of the water make the arrowroot into a thick paste. Soak the gelatin over night in the residue of the water, then put the vessel on a waterbath, and heat until the gelatin is completely dissolved. Now add the arrowroot paste under brisk and constant stirring, and let boil until the arrowroot gelatinizes. Remove from the fire, let cool down somewhat, add the alcohol, and stir until cold.—Nat. Druggist.

Typewriter Ink.—

Transparent soap	1 part
Glycerin	4 parts
Water	12 parts
Alcohol, 94 per cent	24 parts
Anilin color, sufficient.	

Mix the water and glycerin, and in the mixture dissolve the soap by the aid of heat. Dissolve the color in the alcohol, and mix the two solutions. Nigrosin is recommended for black.

The only objection that we have heard to this ink is that it is somewhat hygroscopic in wet weather, and has a tendency to thicken up in long-continued dry weather.

Castor oil has been strongly recommended as a basis for typewriter inks, stamping inks, etc., and it is claimed that inks made with it are not subject to the objections noted above, being very little affected by extreme dryness, moisture, heat or cold, etc. Any of the oil-soluble anilins will answer for a coloring agent, the copying qualities depending on the amount of color used. We would suggest the following, the color being rubbed to smoothness with oleic acid before being mixed with the oil, in every instance.

Red.

Bordeaux red, O. S	15 parts
Anilin red, O. S	15 parts
Crude oleic acid	45 parts
Castor oil enough to make	1,000 parts

Rub the colors up with the oleic acid, add the oil, warming the whole to 100 to 110 deg. F. (not higher) under constant stirring. If the color is not sufficiently intense for your purposes, rub up a trifle more of it with oleic acid, and add it to the ink. By a little experimentation you can get an ink exactly to your desire in the matter.

Blue-Black.

Anilin black, O. S	5 parts
Oleic acid, crude	5 parts
Castor oil, q. s. to	100 parts

Proceed as before.

Violet.

Anilin violet, O. S	3 parts
Crude oleic acid	5 parts
Castor oil, q. s. to	100 parts

Mix. Proceed as in first instance.

The penetration of the ink may be increased *ad libitum* by the addition of a few drops of absolute alcohol, or better, of benzol.—Nat. Drug.

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TABLE OF CONTENTS.

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